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Volume 19, Number 7, April 15, 1965

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstract 11219.

10719 (AECL-2107) ACTIVITIES OF AECL IN THE FIELDS OF BIOLOGY, HEALTH PHYSICS AND MEDICINE. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1964. 34p. Dep.; $1.00(AECL).

Activities in the fields of biology, health physics, and medicine are summarized. Results are reported from studies on the effects of γ dose rate on the number of radio-induced mutations in the small wasp Dahlbominus; the detection of electrical potentials in cockroach eyes following stimulation by x radiation; the capacity of x radiation to induce mutations in a bacteriophage of Escherichia coli; the effects of x radiation on metabolism in the giant mitochondria involved in energy supply to wing muscles of the housefly; radioinduced mutations in yeast; the effects of radiation on histones; the effects of low doses of x or γ radiation on rat thymocytes; the effects of high doses of x radiation on intact erythrocytes; the genetic effects of radiation in rats; the radiosensitivity of lymphocytes; hereditary defects in human populations; the movement of tritium through ground water into the cellulose of trees; the effects of light and temperature on the feeding behavior of Daphnia magna under natural conditions; the metabolism of ^{90}Sr by plants and animals in a small lake; and the development of radiation dosimeters. Activities in industrial safety and health physics are summarized. (C.H.)

10720 (COO-119-231(p.63-9)) REPEATED USE OF ANESTHESIA IN AN EXPERIMENTAL DOG COLONY. G. N. Taylor, C. E. Rehfeld, and J. Wrathal (Utah. Univ., Salt Lake City. Coll. of Medicine).

Extensive use of thiopental sodium anesthesia over a ten year period, primarily for restraint purposes, has proven to be a safe procedure in beagles. Two anesthetic deaths resulted from 8,083 anesthetics given to 762 dogs at a mean interval of approximately 100 days. Residual effects were not detected. The age classes ranged from 3 months to 14 years and included various degrees of health. (auth)

10721 (COO-119-231(p.70-5)) LOW NATURAL INCIDENCE OF OSTEOSARCOMAS IN BEAGLES. Charles W. Mays and Glenn N. Taylor (Utah. Univ., Salt Lake City. Coll. of Medicine).

The occurrence of osteosarcomas in non-irradiated beagles is extremely low, as it also is in man. Based on a literature search and inquiries to veterinary colleges, the fraction of deaths with natural osteosarcomas for beagles in an environment favoring long life is estimated at 1 to 100 osteosarcomas per 100,000 deaths. (auth)

10722 AUTOMATIC LIQUID SCINTILLATION COUNTING OF HIGH-ENERGY BETA EMITTERS IN TISSUE SLICES AND AQUEOUS SOLUTIONS IN THE ABSENCE OF ORGANIC SCINTILLATOR. Hannelore Braunsberg, and A. Guyver (St. Mary's Hospital, London). Anal. Biochem., 10: 86-95(Jan. 1965).

A method is described for counting high-energy β-emitters in an automatic liquid scintillation counter in the absence of organic scintillator. For ^{24}Na, good agreement was found between results obtained by this method and by a well-type scintillation counter. Counting efficiency was 25% for ^{32}P and 13% for ^{24}Na, but less than 1% for low energy emitters such as ^{59}Fe and ^{14}C. The method, which can be used for counting aqueous solutions or tissues, leaves the samples uncontaminated and intact for further experimentation or analysis. (auth)

10723 ION EXCHANGE RESINS IN AGROLOGY. Louis-A. Buscarlet. Bull. Inform. Sci. Tech. (Paris), No. 85, 45-7(July-Aug. 1964). (In French)

In the determination of soil fertility it is necessary to determine the reserve of usable phosphorus, the concentration of the soil solution that corresponds to the quantity of phosphorus immediately available, and the speed of the passage of this element into solution. Chemical methods can be used to determine the first, isotopic methods the second, and ion exchange resins the third. Each of these methods is briefly described. (J.S.R.)

10724 RADIATION DIAGNOSIS, RADIATION HEALTH SCIENCE, AND RADIATION PROTECTION. PART III. Friedrich Ekert (Strahlenabteilung der Krankenhauses, Munich). Muench. Med. Wochschr., 103: 1993-8(Oct. 13, 1961). (In German)

Current topics reviewed include programs for training of radiology personnel, x-ray diagnostic procedures and equipment, films and developers, planning of lab space, techniques for use of contrast media and procedures for anesthesia required during their use, x-ray diagnosis of internal organs, skeleton, and in childbirth and gynecological procedures, techniques of radiotherapeutic treatment of malignant tumors and metastases, supplemental treatment and post-treatment for tumor irradiation, radiation treatment of noncancerous diseases, radiobiology, radiation injuries, radiation hazards, radiation protection, and radiation protection during x-ray diagnosis, radiotherapy, and nonmedical use of radioisotopes. (BBB)

10725 ISOLATION OF PLOIDY MUTANTS OF EHRLICH ASCITES TUMOUR OF MOUSE. S. Bhaskaran and W. Dittrich (Kernforschungzentrum, Karlsruhe, Ger.). Nature, 205: 107-9(Jan. 2, 1965).

To examine the effects of polyploidy on radiosensitivity in mammalian cells, a ploidy mutant was induced from a clone derived from a single cell. 0.5 ml of 2% colchicine was injected intraperitoneally into tumor ascites developed 8 days in mice after transplantation of cells from a selected hyperdiploid clone. After about 2.5 hr, the ascites was withdrawn, and, after washing, either single cells were isolated immediately and directly injected into new-born mice, or more than 10^7 cells were transplanted into adult mice. The subclones thus produced were examined again cytologically. The modal chromosome number in the stem-

line ELD and of the isolated clone $ELDd_1$ was 42 in both cases. The modal chromosome number of isolated hypertetraploid ($ELDt_1$), which was 84, was exactly double that of the parent clone $ELDd_1$. Such hypertetraploid cells occur in the clone $ELDd_1$, immediately after colchicine treatment, with a frequency of about 30%. It thus follows that the isolated subclone $ELDt_1$ is induced by colchicine treatment with a probability ~0.9 and does not originate as a spontaneous mutant. (P.C.H.)

10726 PROCEEDINGS OF THE IX CONGRESS OF THE INTERNATIONAL SOCIETY OF HEMATOLOGY, [UNIVERSITY OF MEXICO, MEXICO CITY, SEPT. 17-23, 1962]. [VOLUME II]. Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 2: 1-720(1964). Mexico City, Universidad Nacional Autónoma de México, 1964. (CONF-620901 (Vol.2))

Separate abstracts were prepared for four papers included in this volume. Three papers were abstracted previously and appeared in NSA Vol. 19 as numbers 92, 191, and 3988. Other papers discuss blood coagulation, immune reactions, blood diseases, and the tissue culture of hematopoietic tissues. (C.H.)

For abstracts of individual papers see: 10727, 10913, 10914, and 10915.

10727 EFFECT OF RARE EARTH ELEMENTS ON COAGULATION. EVIDENCE FOR A NEW CLOTTING FACTOR REQUIRED FOR THROMBOPLASTIN GENERATION. R. W. Colman and B. Alexander (Harvard Medical School, Boston and Beth Israel Hospital, Boston). Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 2: 141-54 (1964).

A new clotting factor was found that is essential for thromboplastin generation, and is distinct from all hitherto known coagulation entities. It is uniquely sensitive to the rare earths and related elements. Their inactivating effects are reversible, indicating no, or incomplete, denaturation. Aside from the biophysical implications suggesting intriguing relationships between the atomic structure of certain cations and their biologic function in coagulation and metalloenzymes, the existence of this clotting factor raises important questions regarding its importance in hemostasis as well as in anticoagulant therapy. Adversely affected by coumarin drugs, deficiency of this factor may help explain the occasionally observed bleeding in patients under treatment whose prothrombin values are maintained at so-called safe therapeutic levels, as judged by the orthodox prothrombin time tests. (auth)

10728 PROCEEDINGS OF THE IX CONGRESS OF THE INTERNATIONAL SOCIETY OF HEMATOLOGY, [UNIVERSITY OF MEXICO, MEXICO CITY, SEPT. 17-23, 1962]. [VOLUME III]. Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 3: 1-674(1964). Mexico City, Universidad Nacional Autónoma de México, 1964. (CONF-620901(Vol.3))

Separate abstracts were prepared for six papers included in this volume. One paper was abstracted previously and appeared in NSA Vol. 16 as No. 31486. Other papers discuss the chemistry and cytology of hematopoietic tissues, abnormal hemoglobins, nucleic acid synthesis, iron metabolism, and neoplasms and dyscrasias of hematopoietic tissues. (C.H.)

For abstracts of individual papers see: 10774, 10866, 10867, 10868, 10916, and 10968.

10729 A QUANTITATIVE STUDY OF CELLULAR SURVIVAL AFTER FREEZING. Phan The Tran, M. A. Bender, and N. P. Buu Hoi (Office National de l'Energie Atomique, Saigon, Viet-Nam). Rev. France. Etudes Clin. Biol., 9: 207-9(1964). (In French)

An epitheloid strain of Girardi heart cells in culture medium was subjected to slow freezing or rapid freezing at −30, −79, and −196°C. Ten % of human serum (type AB, Rh−), 50 IU penicillin G, and 0.5 mg streptomycin per ml were added. The cells were isolated by serial dilution and, after the freezing process, were plated on a Petri dish. This technic is suited to a quantitative study, for a cell colony arises from each surviving cell. Cellular survival, as measured by colony growth, decreased the more rapid the freezing rate used. With slow freezing, cell survival was 4.1%. Rapid freezing at −30°C gave cell survival of 7.2%. At −79°C it declined to 0.2%, and no cells survived when brought directly to −196°C. The addition of protective compounds increased cell survival. Addition of 0.7M mannitol for slow freezing increased cell viability to 13.3%. With rapid freezing at −30°C, mannitol increased viability to 10.7% and at −79°C, to 2.0%. The increase at −196°C was to 2.4%. With 1.6M glycerol added before slow freezing viability increased to 84.0%. At −30°C the increase was to 18.2%, while at −79°C with glycerol viability was 21.2% and at −196°C it was 2.8%. An increase in cell survival depended on the compound added and the freezing technic employed. (BBB)

10730 INTERPRETATIONS CONCERNING CELL DIVISION AND GROWTH. A. H. Haber and D. E. Foard (Oak Ridge National Lab., Tenn.). p.491-503 of "Regulateurs Naturels de la Croissance Vegetale, Colloques Internationaux du Centre National de la Recherche Scientifique, No. 123." Paris, Centre National de la Recherche, 1964.

Fallacies in interpreting the effects of chemicals and light on plant growth are discussed in relation to simple a priori geometric considerations, studies with biological systems in which growth occurs without concurrent cell divisions, and studies with biological systems in which cell divisions occur without concurrent growth. The relevance of the studies to interpretations of actions of growth-regulators (gibberillic acid, indole-3-acetic acid, kinetin, colchicine, red or blue light, unilateral illumination, and gravity) are considered. (H.M.G.)

Ecology

Refer also to abstracts 11391 and 11535.

10731 (NP-14669) SEMI-ANNUAL PROGRESS REPORT [ON RADIOACTIVITY IN FLORA AND FAUNA], MARCH 1961. (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and Italy. Istituto Italiano di Idrobiologia, Pallanza). IAEA Contract 59. 22p. Dep.(mn).

The radioactivity due to fallout and natural sources in aquatic plants, snails, and sediments of Lake Maggiore, Italy, was measured in 1961 as a basis for determining the effects of radioactive wastes from the Ispra Nuclear Center on the ecology of the Lake. Data are presented on the radioactivity of sediments and of plants of the genus Anacharis, that grow profusely in the Lake, and snails, Viviporus ater, and the bivalve, Unio pictorium, that feed on organic detritus and have a wide geographical distribution in the Lake. Results are included from tracer studies of the metabolism of ^{89}Sr and ^{54}Mn in Viviparus. (C.H.)

10732 RADIOACTIVITY AND ITS RELATIONSHIP TO OCEANIC FOOD CHAINS. Charles Osterberg (Oregon State Univ., Corvallis), William G. Pearcy, and Herbert Curl, Jr. J. Marine Res. (Sears Found. Marine Res.), 22: 2-12(Jan. 15, 1964).

Gamma-ray spectra of some primary producers (single-cell plants), filter-feeding herbivores, and carnivores, assigned to trophic levels I, II, and III−V, respectively, were prepared from marine samples taken in the Pacific off Oregon during 1961-1962. The organisms were exposed in their natural environment to both fission products from fallout and neutron-induced radionuclides from reactors on the Columbia River. Comparisons of spectra of organisms from different trophic levels, determined from stomach contents and the literature, show that $^{95}Zr-^{95}Nb$ and ^{141}Ce were concentrated by primary producers and herbivores but not by carnivores. ^{51}Cr was abundant in only filtered samples (primary producers). ^{54}Mn, ^{60}Co, and ^{137}Cs were found in only herbivores and carnivores. ^{65}Zn was found in every marine organism examined. The authors conclude that the abundance of $^{95}Zr-^{95}Nb$ and ^{141}Ce, in particular, may be useful in marine trophic-level studies. Peaks due to these fission products are greatly reduced in spectra of

predaceous animals as compared with spectra of herbivores. (auth)

10733 ADVANCES IN RADIATION ECOLOGY. J. Olson. Nucl. Safety, 6: No. 1, 78-81(1964).

Areas of interest in radiation ecology and biology are described. Papers presented at the First National Symposium on Radiation Ecology, Fort Collins, Colo., 1961, are reviewed. (M.C.G.)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 11390, 11402, and 11426.

10734 (BNL-7767) ZUR RNS-SYNTHESE IM CHROMATIN UND IM NUKLEOLUS DER MENSCHLICHEN KREBSZELLE HeLa-S_3 IN KULTUR. (RNA Synthesis in Chromatin and in the Nucleolus of HeLa-S_3 Human Cancer Cells in Culture). L. E. Feinendegen (European Atomic Energy Community) and V. P. Bond (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 37p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The self-radiographic method was used to investigate the incorporation of the tritium-labeled RNA precursor cytidine in HeLa cells in culture. The distinctive labeling of the RNA in the nucleolus argues for an alternating cohesiveness of the nucleolar function. At least three non-acid soluble RNA fractions could be distinguished: one a RNA of the nucleolar boundary region with relatively rapid transformation, a RNA fraction of the nucleolar center with equal rapid transformation, and a RNA of the nucleolar center with relatively slow transformation. The relations of these fractions with each other did not appear to be dependent on the generation cycle of the cells, but to be subject to other non-detected controls. The results indicate that a part of the RNA of the chromatin is a precursor of the RNA of the nucleolus; acid-soluble nucleotides must play a role. The experimental conditions and procedures are described in detail. (J.S.R.)

10735 (COO-119-231) RESEARCH IN RADIOBIOLOGY. ANNUAL REPORT OF WORK IN PROGRESS ON THE CHRONIC TOXICITY PROGRAM. Thomas F. Dougherty (Utah. Univ., Salt Lake City. Coll. of Medicine). Sept. 30, 1964. Contract AT(11-1)-119. 173p. Dep.(mn); $5.00(cy), 3(mn) OTS.

Separate abstracts were prepared for seven sections of this report. (C.H.)

For abstracts of individual sections see: 10720, 10721, 10736, 10737, 10738, 10739, and 10783.

10736 (COO-119-231(p.6-62)) INJECTION TABLES. (Utah. Univ., Salt Lake City. Coll. of Medicine).

Data are presented on the toxic effects of various doses of ^{226}Ra, ^{239}Pu, ^{228}Ra, ^{228}Th, and ^{90}Sr in dogs injected at approximately 17 mo. of age. Test animals were sacrified for special studies and the other animals were maintained until sacrifice became a clinical necessity. (C.H.)

10737 (COO-119-231(p.85-98)) SERUM LACTIC DEHYDROGENASE LEVELS IN ADULT BEAGLE DOGS. Ann G. Ruhmann and David L. Berliner (Utah. Univ., Salt Lake City. Coll. of Medicine).

Serum lactic dehydrogenase (LDH) determinations were performed on 101 beagles from a colony used in the study of long range effects of internally deposited radionuclides. Statistical analysis of results revealed no significant differences among groups separated by radioisotope injected, number of days elapsed since nuclide injected, and disease state. Sera from moderately hemolyzed blood samples were significantly higher in LDH level than sera from nonhemolyzed or slightly hemolyzed blood samples. Dogs who received high doses of radionuclides had blood LDH levels significantly higher than those of control dogs. It is concluded that serum LDH is not a consistent indicator of pathologic states in the adult beagle dog. (auth)

10738 (COO-119-231(p.99-109)) CHEMICAL STATE OF Pu IV IN BEAGLE BLOOD. F. W. Bruenger, W. Stevens, B. J. Stover, and D. L. Berliner (Utah. Univ., Salt Lake City. Coll. of Medicine).

The method of gel-filtration was used to study in vitro the binding and the distribution of ^{239}Pu in dog plasma. It was found that the main portion of Pu was bound by albumin. Only a small amount of plutonium was associated with high molecular weight proteins. The medium weight globulins of type 7S and 4-5S were essentially free of plutonium. (auth)

10739 (COO-119-231(p.110-72)) METABOLISM OF THE Th^{228} DECAY SERIES IN ADULT BEAGLE DOGS. II. Ra^{224} (ThX), Pb^{212} (ThB), AND Bi^{212}(ThC). Betsy J. Stover, David R. Atherton, Dawn S. Buster, and Nancy Keller (Utah. Univ., Salt Lake City. Coll. of Medicine).

Retention and distribution of ^{224}Ra, ^{212}Pb, and ^{212}Bi in beagles was studied through three years after the intravenous injection of ^{228}Th, the parent nuclide, with the decay products in equilibrium. Initially ^{224}Ra in plasma decreased more rapidly than ^{228}Th in plasma. ^{212}Pb was associated with blood cells. Later the concentrations of ^{224}Ra in plasma and ^{212}Pb in cells were respectively 24 and 480 times that of ^{228}Th in plasma. ^{212}Bi in plasma was about twice ^{224}Ra and in cells it was about 0.9 ^{212}Pb. Measurements made for a 30-day period showed that the biological rates of decrease of ^{224}Ra and ^{212}Pb were about the same as those of ^{228}Th. The biological rate constants for the 3 nuclides in bone were found to be of the order of 0.1 of the physical decay constant. For blood, excreta, and soft tissues the biological rate constants were found to be the same order of magnitude as the physical decay constant. Average radiation dose rates to bone, liver, and kidneys were estimated, and the problem of evaluating the loci of decay of ^{220}Tn and ^{216}Po is discussed. (auth)

10740 (DPSPU-64-30-9) OBSERVATION OF BIOLOGICAL HALF LIFE OF TRITIUM. H. L. Butler and J. H. LeRoy (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). May 1964. Contract AT(07-2)-1. 9p. (CONF-642-24). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Health Physics Society, Cincinnati, June 1964.

Over the past ten years 309,000 urine samples were radioassayed for tritium. Most of the samples were analyzed using a liquid scintillation counting technique. In 310 cases the tritium concentration in urine was at least 20 μc/liter. The biological half life values for these cases ranged from 4 to 18 days, with an average of 9.5 ± 4.1 days (90% confidence level). Factors which influence biological half life, such as outdoor temperatures, amount of tritium assimilated, and age of employee were studied. During the warmer months, the average half life was observed to be lower; this was attributed to increased water intake. Data showed no correlation between the amount assimilated and biological half life. A trend toward a shorter half life was observed for increasing age. (auth)

10741 (TID-21559) LOCALIZATION, PERSISTENCE AND RESULTANT GENETIC EFFECTS IN INVERTEBRATES OF INGESTED FOURTH PERIOD METALS IN STABLE AND RADIOACTIVE FORMS. Final Report. D. S. Grosch (North Carolina State Coll., Raleigh). Oct. 1964. Contract AT(40-1)-2836. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The effects of the ingestion of a single meal of sucrose solution containing sulfates of Mn, Fe, Co, Ni, Cu, or Zn on the fecundity, fertility, life span, and phenotype of the wasps, Habrobracon juglandis and H. seriopae, were measured. Cobalt and Ni were the most toxic from the standpoint of altered fecundity and fertility. Cu and Zn had only moderate effect at sublethal doses, and Mn and Fe had little effect. Exposure of females fed Mn, Ca, Ni, Cu, or Zn to single or fractionated non-sterilizing doses of x radiation showed a synergistic effect for x radiation and feeding of these cations. Feeding ^{58}Co, ^{63}Ni, or ^{65}Zn at concentrations of 100 μc/ml gave results characteristic of metal poisoning rather than radiation damage. Results are included from measurements of radioisotope distribution using standard counting and autoradiographic techniques, determinations of the relative radioactivity of eggs, and studies on the effects of tissue transplants on egg production. (C.H.)

10742 (CEA-tr-R-1757) BIOSYNTHÈSE DE LA VITAMINE B_{12} MARQUÉE AU ^{60}Co. (Biosynthesis of Vitamin B_{12} Labeled With Co^{60}). L. N. Bourtseva. Translated into French from Russian. Sept. 4, 1964. 11p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

A method for the biosynthesis of vitamin B_{12} labeled with ^{60}Co is described in which propionic bacteria are cultivated in a nutritive medium without cobalt and the cobalt is added during the fermentation stage. Paper chromatography was used to identify and verify the radiochemical purity of the vitamin B_{12}–^{60}Co. (J.S.R.)

10743 (JPRS-27565) CERTAIN PROBLEMS IN THE TOXICOLOGY OF INSOLUBLE THORIUM-232 AND URANIUM-238 COMPOUNDS. E. B. Kurlyandskaya. Translated from Materialy po Toksikol. Radioaktivn. Vseshchestv, [Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR], No. 4, 3-9; 118(1964). 12p. (TT-64-51813). $1.00(OTS).

Experimental research in toxicology of insoluble thorium and uranium compounds is described, with particular reference to thorium dioxide and U_3O_8. Review of ThO_2-injection experiments in rats revealed that marked changes were not evident in early postirradiation periods, indicating that ThO_2 possesses little true toxicity. On the other hand, neoplasm development following intratracheal administration of small doses in rats lead to the conclusion that ThO_2 is one of the most toxic radioactive substances. When U_3O_8 was given to dogs, it was found that: gastrointestinal absorption (hence, retention) was low; erythrocytes were not affected, but leukocytes showed a tendency toward neutrophilia; a degree of hyperplasia was evident in the spleen and lymph nodes; and slight degenerative processes were noted in the kidneys. Based on these findings, U_3O_8 was determined to be slightly toxic. However, studies of intratracheal administration in rabbits and dogs implied significant radio- and chemical toxicity. (H.M.G.)

10744 THE EFFECT OF OXYGEN AT HIGH PRESSURE ON THYROID FUNCTION IN THE RAT. J. Sjostrand (Univ. of Göteborg). Acta Physiol. Scand., 62: 94-100 (Sept.-Oct. 1964.

The effect of exposure to oxygen at high pressure (OHP) on ^{131}I incorporation by the thyroid was studied. Rats were exposed to oxygen at 6 daily for 4-5 days and killed on the sixth day. The animals showed a very low incidence of convulsions. The thyroid weight was decreased but the uptake of ^{131}I in the thyroid was increased. The increase of ^{131}I uptake of the thyroid per 100 g body weight per mg thyroid weight was highly significant in the OHP exposed rats. Rats subjected to stress by formalin injections were investigated for comparison. The thyroid ^{131}I uptake was significantly higher in rats exposed to OHP than in rats treated with formalin injections. There was thus an increase in the total amount of ^{131}I 24 hours after injection in the thyroid associated with the OHP and it seems probable that this was a specific reaction, different from the well-known response to non-specific stress. (BBB)

10745 RADIOLABELING OF γ-AMINOBUTYRYLCHOLINE BY INJECTION OF ^{14}C-GLUTAMINE. K. Dross and H. Kewitz (Freie Universität, Berlin). Arch. Exptl. Pathol. Pharmakol., 247: 320(1964). (In German)

Labeled glutamine has been used to label γ-aminobutyrylcholine, in preference to other precursors (γ-aminobutyric acids, glutamic acid, choline). Glutamine (2 mg, 30 μC) was administered parenterally to a mouse. After 15 min the animal was sacrificed, and the brain removed and frozen. Water-soluble materials were removed by extraction and separated paper chromatographically. In addition to glutamine, glutamic acid, glutathione, γ-aminobutyric acid, α-ketoglutaric acid, and succinic acid, γ-aminobutyrylcholine was also radioactively labeled. On rechromatography with another solvent mixture and on addition of unlabeled γ-aminobutyrylcholine the R_f value and the shape of the spot obtained with Dragendorff's solution were identical with the autoradiographic darkening. In brain homogenate (1 : 4) to which choline, eserine, Mg, ATP, cysteine, pyridoxal phosphate, glucose, and 16 μC ^{14}C-glutamine are added, radiolabeled γ-aminobutyrylcholine is formed on 1-hr incubation at 38°C, which may be identified by the same techniques described above. The procedure may be used to study the biosynthesis of γ-aminobutyrylcholine. (BBB)

10746 STUDY OF THYROID METABOLISM BY ^{125}I AND ^{131}I. M. Camus, J. Kinthaert, and A. M. Ermans (Université Libre, Brussels). Arch. Intern. Physiol. Biochem., 72: 360-1(Mar. 1964). (In French)

The possibility now exists, owing to the recent wide availability of ^{125}I, of enlarging the field of thyroid study, by combining its use with that of ^{131}I in a double isotope technique. Their different physical properties permit them to be discriminated in the same sample, spectrometrically. Discrimination is complete for ^{131}I, but a correction factor is required for ^{125}I. The longer half life of ^{125}I permits determination of its distribution at equilibrium, even after weak doses, and the nature of its radiation makes it only half as hazardous to thyroid tissue as ^{131}I. The double isotope technique has been used for different types of thyroid function study, such as in the determination of the dynamics of iodine metabolism and in the kinetics of intrathyroidal hormonogenesis. A preliminary study using double isotopes confirmed the existence of a marked excess of monoiodotyrosine (MIT) over diiodotyrosine (DIT) in hydrolyzates of the glands in cases of euthyroid goiter. This technique produced evidence that the MIT/DIT ratio reaches a characteristic value that is constant some hours following the administration of labeled I; it would imply that this ratio is not simply an expression of the transformation of MIT into DIT. (BBB)

10747 CHARACTER OF CERIUM FIXATION BY PROTEIN. Yu. A. Belyaev. Biochemistry (USSR) (English Transl.), 28: 521-4(July-Aug. 1963). Translated from Biokhimiya 28: 635-8(July-Aug. 1963).

Esterification of rat liver globulin carboxyl groups leads to appreciable decrease in protein capacity to bind cerium cations. Cerium complex in anion reacts mainly with free amino groups of globulin molecule. Substitution of NH_2-groups in globulin molecule by OH-groups leads to an increase in amount of bound Ce^{3+}. N-acylated globulin reacts very slightly with cerium in a complex form; DNP-globulin does not bind this form of cerium at all. (auth)

10748 RADIOCALCIUM INTESTINAL ABSORPTION IN THYROTOXIC OSTEOPATHY. C. Gennari (Università, Siena, Italy). Boll. Soc. Ital. Biol. Sper., 40: 253-6 (Mar. 31, 1964). (In Italian)

Three subjects were given 30 to 40 μC of $^{45}CaCl_2$ orally. Subject one was a control, normal in every respect. Subject two, age 30, with thyrotoxicosis for some years, showed the following values in the ^{131}I function test: uptake in 24 hr, 72%, conversion rate in 24 hr, 70%. No evidence of osteoporosis or of phosphorus-calcium metabolism disorders were found. Subject three, age 47, with exophthalmic goiter, showed an ^{131}I uptake value 78% and conversion rate 75%. The ^{45}Ca balance study showed a severe negative balance with high levels of urinary and fecal Ca, and x-ray films showed a high degree of diffuse osteoporosis. The following are the ^{45}Ca intestinal absorption values obtained for subjects one, two, and three: blood plasma after 30 min 0.5%, 0.5%, and 0.5% of the dose; 60 min 2.1%, 2.0%, and 1%; 90 min 2.4%, 2.2%, and 1.2%; 120 min 2.3%, 2.1%, and 1.5%; 240 min 2.1%, 2.0%, and 1.4%; urine 6 hr 1%, 0.9%, and 0.3% of the dose; and feces after 72 hr 37%, 30%, and 50% of the dose. The evidence of intestinal absorption deficiency of ^{45}Ca in the exophthalmic goiter subject suggests the hypothesis that the observed hypocalcemia could be caused by the impaired intestinal absorption of Ca which, as a pathogenic sequel, influences secondarily the activity of the parathyroid glands. (BBB)

10749 A CASE OF ACCIDENTAL INHALATION OF IRRADIATED URANIUM. J. Rundo (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. J. Radiol., 38: 39-50(Jan. 1965).

A case of accidental inhalation of irradiated uranium was studied by body radioactivity measurement for 850 days. The whole-body retentions of ^{137}Cs, $^{95}Zr/^{95}Nb$, ^{103}Ru, and $^{141}Ce + ^{144}Ce$ were all measured; the biological half-lives were 113 days, 250 days, ⩽230 days and ⩽2,800 days for

these radionuclides respectively. The results suggested that after the first week there were no major changes in the distribution of the radioactivity in vivo, although there may have been some translocation of the cerium from lung to lymph nodes. The ^{137}Cs content was used to estimate a lower limit for the amount of uranium deposited initially in the lung, while the ^{95}Zr content six days after inhalation was used to estimate the amount of uranium retained. The latter was probably not more than 6 per cent of the former. The fate of the uranium was unknown. The implications of the findings to the calculation of maximum permissible concentrations in air of insoluble radioactive material are discussed. Some recommendations are made for the investigations of possible future cases, to eliminate some of the speculation involved in the present discussion. (auth)

10750 COMPARATIVE INVESTIGATIONS ON BINDING OF RADIOACTIVE CHROMIUM (^{51}Cr) BY VARIOUS CELL POPULATIONS IN VITRO. J. Doroszewski (School of Medicine, Warsaw). Bull. Acad. Polon. Sci., Ser, Sci. Biol., 12: 421-6(1964).

Comparative studies were carried out of the binding of ^{51}Cr in vitro by erythrocytes, bone marrow cells, lymphocytes, thymocytes, and spleen cells. The degree of ^{51}Cr incorporation for the various cells is given. The incorporation mechanism is discussed and considered in relation to the biological role of Cr. The applicability of the method of cell labelling with ^{51}Cr was analyzed. (M.J.T.)

10751 MEASUREMENT OF MUSCLE BLOOD FLOW IN THE HUMAN FOREARM WITH RADIOACTIVE KRYPTON AND XENON. Gerald B. Holzman, Henry N. Wagner, Jr., Massahiro Iio, David Rabinowitz, and Kenneth L. Zierler (Johns Hopkins Univ., Baltimore). Circulation, 30: 27-34 (July 1964).

In the past, ^{24}Na or ^{131}I has been used as a tracer measuring blood flow, but with considerable variability in the results obtained in serial studies of the same persons. The gases ^{85}Kr and ^{133}Xe have certain advantages over ^{24}Na and ^{131}I. They are chemically and physiologically inert; they are not normally present in the body; and they are rapidly excreted from the body via the lungs. The long physical half life of ^{85}Kr (10.3 yr) and the half life of ^{133}Xe (5.27 days) make the use of these nuclides more convenient than ^{24}Na (15 hr). Finally, the lower γ-ray energies of ^{85}Kr (0.513 Mev) and ^{133}Xe (0.081 Mev) are more suitable for external radiation detection than the high energy of ^{24}Na (1.368 Mev), which is difficult to localize accurately in the body. Accordingly, blood flow to forearm muscle was estimated by external monitoring of the rate of disappearance of radioactivity following intramuscular injection of an aqueous solution of ^{85}Kr or ^{133}Xe. Carrier-free ^{85}Kr and ^{133}Xe, in a gaseous state, were equilibrated in phosphate buffer at pH 7.0. The volume of one C of radioactive gas was ~3 to 5 ml in equilibrium with about 35 ml of buffer solution. In this way a highly concentrated aqueous solution of ^{85}Kr and ^{133}Xe was obtained despite the slight water solubility of these gases. The aqueous solution was sterilized by passage through a membrane Millipore filter, with care to avoid contact with air. Terminal calibration of the dose was made by comparison with a sealed ^{85}Kr standard. Calibration of ^{133}Xe was with ^{170}Tm, which has a γ emission of 0.084 Mev and a half life of 127 days. Final concentration of both gases was usually 500 to 1000 μC/ml. To measure forearm muscle blood flow, the solution was injected into the forearm, and immediately a collimated NaI (Tl activated) crystal scintillation detector was placed directly over the injection site to record radioactivity by means of a γ-ray spectrometer, count rate meter, and linear chart recorder. In five healthy adult men, forearm muscle blood flow was estimated simultaneously by two methods, the ^{85}Kr or ^{133}Xe method and the constant injection dye-dilution method. The flow determined by the ^{85}Kr clearance was from 0.95 to 1.65 times greater than the value obtained by the dye-dilution technic. The mean difference between the two methods was 23%, the range of difference being 6 to 49%. The correlation coefficient was 0.75. Estimates of ^{85}Kr averaged 1.28 times faster and ^{133}Xe estimations 1.34 times faster than the dye-dilution determinations. When measured simultaneously, ^{85}Kr clearance was consistently slower than both ^{133}Xe and ^{24}Na. An important difference between ^{24}N, ^{85}Kr, and ^{133}Xe is their relative solubility in fat, the last being the most soluble. The difference between the clearance rates of ^{85}Kr and ^{133}Xe can be attributed to the greater solubility of ^{133}Xe in blood relative to skeletal muscle. Differences in clearance rates of both ^{85}Kr and ^{133}Xe result from the relative proportions of lipid and water in a given individual. The technic is of greatest value in serial measurements in the same individual. Since the mean per cent difference between the paired studies in the same individual was 32%, one would be able to detect changes in blood flow of this order of magnitude. (BBB)

10752 THE MEASUREMENT OF WHOLE-BODY POTASSIUM BY GAMMA-RAY SPECTROMETRY AND ITS RELATION TO TOTAL BODY WATER IN DOGS. R. E. Williams, D. Hughes, F. Lee, A. H. Smith, G. A. Young, and F. M. Parsons (Univ. of Leeds, Eng.). Clin. Sci., 27: 305-12(Oct. 1964).

A method is described for estimating whole-body K content by the measurement of the γ radiation from the ^{40}K isotope which occurs with constant abundance (0.0118%) in natural K. Data are presented on the whole-body K content of 21 dogs measured by γ-ray spectrometry with particular reference to the relation of whole-body K to total-body water measured by the dilution of N-acetyl-4-aminophenazone (NAAP), and of tritiated water. The possibility is considered of using this relation to predict normal values of whole-body K from measurements of total-body water when the latter is known to be normal. The ability to do this would be of value in many biological circumstances and in particular, in the clinical diagnosis and management of K deficiency in humans. Conversely, the observed levels of whole-body K and total-body water can be used to assess abnormalities of water content when the whole-body K is normal. In all cases the total-body water volume estimated by the dilution of ^3H_2O exceeded that given by NAAP. The mean excess was 7.5% of the volume given by NAAP. This excess is consistent with the two effects reported of the exchange of ^3H with labile H in body components other than water and the slow penetration of NAAP. The geometrical distribution of ^{42}K in the dog at about six hr after intravenous injection was adequate for calibration of the whole-body counter as no further change in response with time was demonstrated, and studies with humans showed that a time interval of five hr is sufficient after intravenous injection but that up to 12 hr is necessary after oral administration. However, ^{42}K has not reached full metabolic equilibrium in these times. Regression equations for whole-body K in terms of gross body weight and total body water by the two dilution methods are given. It is concluded that whole-body counting provides a very useful technique, involving minimum trouble to the patient, for the direct measurement of the whole-body K. When adequate calibration procedures have been established, rapid measurements can be made without the necessity of administering a radioactive tracer, with the concomitant radiation dose, as in exchangeable K studies, and repeated measurements can be made at short intervals. (BBB)

10753 STUDY OF THE INCORPORATION IN VIVO OF ^{32}P IN THE PHOSPHOPROTEINS IN THE RAT LIVER. Christiane Blat and Louise Harel (C.N.R.S., Villejuif, France). Compt. Rend., 259: 3659-62(Nov. 16, 1964). (In French)

A kinetic study of the incorporation of phosphorus in the hepatic phosphoproteins of the rat showed an incorporation maximum 1 hr, 30 min after injection of $Na_2H^{32}PO_4$. The maximum corresponded to that found for ATP and the mineral phosphorus of the cell, the exchange between these compounds being very rapid. It was the same for the phosphoproteins of each of the isolated cellular structures, taken apart from the nuclei. In the nuclei, the concentration of phosphoproteins was high, but their specific radioactivity was low. (tr-auth)

10754 SOFT TISSUE RETENTION OF ^{226}Ra IN THE BEAGLE. David R. Atherton, Betsy J. Stover, and

Charles W. Mays (Univ. of Utah, Salt Lake City). Health Phys., 11: 101-8(Feb. 1965).

Results of measurements of radium retained in soft tissues of beagles from 1 day to 8 years after injection are presented. The relative contribution of soft tissue to total-body retention decreases with increasing time after injection. After 2 months, soft tissue retention is less than 3 per cent of the whole-body content. About 40 per cent of the amount in soft tissue is found in liver, kidneys and spleen. (auth)

10755 ABSORPTION AND MOBILITY OF STRONTIUM AND CESIUM OF FRUIT VEGETABLES USING Sr-89 AND Cs-134 AS TRACERS. Yu-yuan Yeh (National Taiwan Univ., China). Ho Tsu K'o Hsueh, 4: 139-47(Feb. 1964). (In Chinese)

The absorption and translocation of ^{134}Cs and ^{89}Sr applied as spray to the foliage of bush bean and tomato plants when the fruits were nearly mature were studied. ^{89}Sr and ^{134}Cs had accumulated in both the flesh and seeds 24 hr after application. The percentage of total activity recovered in the flesh and seeds increased with the translocation period, while for the same translocation period the percentage of translocation was higher for Cs than for Sr, particularly in tomato fruits. Autoradiography also supported the observations on the mobility and uptake of Cs and Sr; the distribution of radioactive materials moved gradually into the tomato fruits from the outer to the inner layer. (D.C.W.)

10756 INFLUENCE OF THE GASTROINTESTINAL IODIDE CYCLE ON THE EARLY DISTRIBUTION OF RADIOACTIVE IODIDE IN MAN. Marguerite T. Hays and David H. Solomon (Univ. of California, Los Angeles). J. Clin. Invest., 44: 117-27(Jan. 1965).

The salivary-gastric-enteric cycle of radioactive iodide was studied during the first three hrs after isotope administration in nine normal subjects. Radioiodide in the thyroid, plasma, urine, and pooled salivary-gastric secretions was measured frequently. Control sessions for each subject were identical, except that no secretions were aspirated from the gastric tube. Radioiodide recovered from the stomach averaged 23% of that administered (range, 11 to 44%). Thyroidal clearance averaged 16 ml per minute; renal clearance, 34 ml per minute; and gastrosalivary clearance (not corrected for dead space), 46 ml per minute. When gastric contents were removed, the nonthyroidal, nonurinary volume of distribution remained constant (averaging 20.1 L or 27% of body weight) after the first hour, and plasma radioactivity declined along a simple exponential curve. The rate of this decline could be accounted for by the summed thyroidal, renal, and gastro-salivary clearance rates. In the control sessions, the increase in volume of distribution persisted longer, and in four subjects it was still evident at 180 minutes. Thigh/plasma ratio became constant after 1 hr, but was not so good a predictor of nongastrointestinal volume of distribution as was body weight. Curves of plasma radioactivity in the control sessions varied greatly among the individuals and did not follow a simple exponential function. This difference must be due to the effect of intestinal reabsorption of radioiodide previously cleared. (auth)

10757 A NEW ORAL ISOTOPIC TEST OF CALCIUM ABSORPTION. Louis V. Avioli, Joseph E. McDonald, Richard A. Singer, and Philip H. Henneman (Seton Hall Coll., Jersey City, N. J.). J. Clin. Invest., 44: 128-39 (Jan. 1965).

A simple 4-hr isotope test for in vivo analysis of calcium absorption in man was evaluated in 21 normal adults, in 14 patients with decreased intestinal absorption, and in 17 patients with disorders characterized by increased calcium absorption. A significant correlation was obtained between 1-hr plasma radioactivity and the per cent of ^{47}Ca absorbed during simultaneous cumulative 6-day fecal radioactivity measurements. Normal subjects demonstrate a rapid uptake of ^{47}Ca with maximal plasma values at 1 hour followed by a gradual decline in the subsequent 3-hr period. Patients with malabsorptive disorders demonstrate delayed absorption with lower plasma radioactivity at 1 hr. Abnormal absorption patterns in these patients were restored toward normal by vitamin D. Patients with disorders characterized by increased calcium absorption demonstrated accentuation of the normal pattern. Serial 4-hr oral ^{47}Ca tests in these patients revealed suppression of the increased calcium absorption during sodium phytate therapy. (auth)

10758 I^{131} CONTENT IN OVARIAL AND OTHER TISSUES AT DIFFERENT TIMES AFTER ORAL ADMINISTRATION. Titus C. Evans, Robert E. Hodges, and James T. Bradbury (State Univ. of Iowa, Iowa City). J. Nucl. Med. 5: 733-7(Oct. 1964).

Results of tracer studies in pregnant women showed that the human ovary does not concentrate ^{131}I when given as NaI. The great concentration in the fetal thyroid over that of the blood differential absorption ratio (DAR) was demonstrated. The DAR of the fetal thyroid increases from about 75 to as much as 22,000 as the fetus develops from the third to the sixth month of gestation. It was also demonstrated in one instance that ^{131}I as T3 crossed the placenta and was concentrated loosely in the fetal thyroid with a DAR of about 8.5. (auth)

10759 ABSORPTION AND EXCRETION OF 131-IODINE-LABELED ATABRINE. Leopoldo Jose Anghileri (Comision Nacional de Energia Atomica, Buenos Aires). J. Nucl. Med., 5: 936-41(Dec. 1964).

The preparation of ^{131}I-labeled Atabrine is described. Data are included on the tissue distribution of ^{131}I-atabrine in rats. (C.H.)

10760 ALTERATION OF ^{90}Sr METABOLISM IN THE GROWING RAT BY FAT-SOLUBLE VITAMINS. PART I. THE EFFECT OF VITAMIN D_3. B. Schmidt and K. Lang (Physiologisch-Chemisches Institut, Mainz). Klin. Wochschr., 42: 942-8(Oct. 1, 1964). (In German)

The effect of vitamin D_3 on the metabolism of ^{90}Sr was studied in growing rats fed with a diet containing a constant level of ^{90}Sr but different amounts of vitamin D_3. The diet contained 1750 pC ^{90}Sr/g dietary Ca, which corresponds to ~250 times the contamination of milk in 1957 (7 pC ^{90}Sr/g Ca). Physiological doses (50 IU/day) or slightly enhanced doses (500 IU/day) of vitamin D_3 caused no significant effects on ^{90}Sr excretion. Largely increased doses (5000 IU/day) of vitamin D_3 caused toxic effects. This affected ^{90}Sr metabolism in several ways. Firstly, the intestinal absorption of ^{90}Sr is largely increased, as judged by the reduced excretion in feces, while body growth is delayed and food uptake insufficient. Secondly, retention of ^{90}Sr in the skeleton is increased in hypervitaminosis D in spite of insufficient calcification. The level of ^{90}Sr in the blood is raised due to the improved Sr absorption caused by excess vitamin D_3; therefore, the renal excretion of ^{90}Sr and Ca rises with increasing vitamin D doses. Discrimination toward Sr and Ca is altered, as shown by data relating to mineral metabolism, which changes continuously with increasing vitamin D_3 doses. Thus, the efficiency of discrimination by the intestinal epithelium is lowered with increasing doses of vitamin D_3. The same holds true for the discrimination in the skeleton. The kidneys are injured by mineral deposition after high doses of vitamin D_3, and as a consequence the discrimination efficiency decreases, resulting in a relatively lower renal excretion of Sr as compared with Ca. (BBB)

10761 MUTATION IN THE WAXY CHARACTER IN BARLEY POLLEN GRAINS FOLLOWING 90-Sr-INCORPORATION AT LOW ACTIVITIES. Lars Ehrenberg and Goesta Eriksson (Univ. of Stockholm and Royal Coll. of Forestry, Stockholm). Mutation Res., 1: 139-45(July 1964).

Reversions and forward mutations in the waxy character were determined in the pollen grains of barley plants grown in a Ca-poor soil treated with 8 to 160 μC ^{90}Sr/kg of soil. An increased mutation rate could be determined at isotope contents down to about 2 nC/g fresh weight, corresponding to a dose rate of about 0.04 rad/day. The frequency of induced reversions depended exponentially on dose, in agreement with the effect of acute γ-irradiation. The relationship between forward mutation rate and dose

was more complicated. The low doses gave higher mutation rates than expected from a linear dependence. (auth)

10762 MANGANESE-54 CONCENTRATION IN FALLOUT, WATER, AND UNIO MUSSELS OF LAKE MAGGIORE, 1960-63. P. Gaglione and O. Ravera (EURATOM Joint Research Center, Ispra, Italy). Nature, 204: 1215-16(Dec. 19, 1964).

It is noted that unio (mollusca, lamellibranchia) has the ability to concentrate Mn. To determine whether ^{54}Mn is accumulated by unio, this isotope was measured in the organism and compared with results of measurements in lake water and fallout during 1960 to 63. Results indicate that unio is a valid bio-index for ^{54}Mn contamination. (J.R.D.)

10763 INFLUENCE OF SOIL ORGANIC MATTER ON THE ENTRY OF CAESIUM-137 INTO PLANTS. D. A. Barber (Agricultural Research Council, Wantage, Berks, Eng.). Nature, 204: 1326-7(Dec. 26, 1964).

The uptake of ^{137}Cs by ryegrass from pasture soils was investigated. Soil samples to a depth of 10 cm were collected from permanent pastures at five sites in Britain where levels of ^{137}Cs had been observed in milk. A tropical soil was included for comparison. Among soils the uptake of ^{137}Cs varied by factors of up to about 20 when the results were expressed in terms of the amount of ^{137}Cs absorbed per pot and the uptake per g of plant tissue. Coefficients of the effects of both the percentage organic matter content and the cation exchange capacity of the organic matter on the uptake of ^{137}Cs were significant at the 0.1% level. It is suggested that these relations reflect the fact that, when organic matter is responsible for a large fraction of the total exchange capacity of the soil, the adsorption and the subsequent fixation of ^{137}Cs on the clay minerals are much reduced. (P.C.H).

10764 ACTION OF NON-PENETRATING HEAVY METALS ON THE CATALASE ACTIVITY OF YEAST CELLS. J. Gordin Kaplan (Dalhousie Univ., Halifax, N. S.). Nature, 205: 76-7(Jan. 2, 1965).

The effects of Hg and UO_2^{2+} on catalase activity of yeast cells were investigated. It was found that when yeast suspensions were pre-treated with either 8×10^{-5} or 10^{-4} M, Hg^{2+}, washed and then assayed either directly or after lysis inhibition of the patent catalase was of the order of 25%; on the other hand, the cryptic enzyme was inhibited by only about 2%, and this inhibition was statistically insignificant. Using varying concentrations of UO_2^{2+}, the patent activity was virtually abolished at a concentration of 0.1 M, whereas the enzyme of the butanolysed cells was completely inactivated at 5×10^{-4} M UO_2^{2+}, and was thus about 500 times more sensitive. The inhibition of patent activity could be reversed to some extent by high substrate concentration, but that of the lysed cells could not. It was concluded that uranyl ion, which was found not to penetrate the cell membrane, could completely inhibit the patent catalase activity of yeast. (P.C.H.)

10765 RETENTION OF ^{90}Sr IN LACTATING RATS. W. E. Kollmer and H. Kriegel (Heiligenberg Inst., Ger.). Nature, 205: 196-7(Jan. 9, 1965).

The metabolism of Sr during lactation was studied in rats following the injection of females with ^{90}Sr at various times during gestation and lactation. The femora of dams and total litters were ashed dry and radioactivities of samples of the ash from each femur were measured and calculated for the litter. Results indicated that the radioactivities of the juveniles was roughly doubled during the 3 to 5 postpartum days as compared to the 17 to 19 days of gestation. Participation of the litter in a dose of ^{90}Sr injected during lactation showed a continued increase. (C.H.)

10766 ABSORPTION AND RETENTION OF INGESTED STRONTIUM AND CALCIUM IN BEAGLES AS A FUNCTION OF AGE. R. J. Della Rosa, M. Goldman, A. C. Anderson, C. W. Mays, and B. J. Stover (Univ. of California, Davis). Nature, 205: 197-8(Jan. 9, 1965).

The absorption and retention of Ca and Sr were determined in dogs of different ages after the ingestion of a single meal containing known amounts of ^{85}Sr and ^{47}Ca. Results indicate that Ca and Sr are absorbed in a qualitatively similar manner. The absorption and retention of administered ^{85}Sr and ^{47}Ca decreased rapidly with increasing age of the animals. The highest absorption was observed in the youngest dogs. (C.H.)

10767 UPTAKE OF CHROMIUM(III) BY PARTICLES IN SEA-WATER. Herbert Curl, Jr., Norman Cutshall, and Charles Osterberg (Oregon State Univ., Corvallis). Nature, 205: 275-6(Jan. 16, 1965).

Uptake of ^{51}Cr(III) by ten species of phytoplankton algae was measured, but no appreciable differences among species were noted. However, small cells appeared to accumulate somewhat more isotope per cell per unit time than did large cells. Experiments used both living cells in the light and in the dark, and dead cells killed either by heat (100°C for 10 min) or by the addition of formaldehyde. In general, uptake was rapid. Equilibrium was always reached within 24 hr. It was concluded that there is no doubt that Cr(III) is actively adsorbed on living and dead particles at all pH values normal for sea water. (P.C.H.)

10768 TRANSFER AND DISTRIBUTION OF ^{131}I IN LAYING HENS. Hiroshi Nozaki and Masaharu Oshima. Nogyo Gijutsu Kenkyusho Hokoku, Chikusan, No. 19, 59-67 (Aug. 1960). (In Japanese)

The transmission, distribution, and excretion of ^{131}I in the laying hen was investigated. $Na^{131}I$ aqueous solution, about 50 μC per 0.5 ml was injected intramuscularly into three laying hens, and radioactivity of ^{131}I appearing in eggs and excreta was measured daily for three weeks. At the end of the experiment the hens were slaughtered and the distribution of radioiodine in the chief organs of the body was examined. The radioiodine concentration in the blood reached a maximum within 24 hours and decreased to 1 to 3% of the maximum value on the 6th day after dosing. Thereafter the rate of loss is shown by an exponential curve and 3 weeks later the amount was about equal to the limit of measurements. Similar exponential curves were obtained in the decreasing rate of radioiodine from the excreta, egg white, and egg yolk, which was laid later than 10 days after injection. From 3 to 5 days after dosing the amount of radioiodine in the laid eggs reached the maximum and such eggs may include about 3% of the administered dose. From 2 to 9 days after dosing the radioactivity found in eggs is greater than the total activity found in the excreta of the corresponding days, amounting to ten times or more of the latter during the period from the 4th to 7th day. It, however, remained to 40 to 60% after the 13th days. A decreasing rate of ^{131}I excreted was approximately the same as that of the blood or the egg white. The total radioiodine excreted in the excreta during 3 weeks period amounted to about 40% of the administered dose, while about 80% of that was excreted within 24 hours after dosing. On the 23rd day after dosing, the thyroid of the hen retained about 0.6% (if decay corrected, about 4%) of the administered dose, and in other organs little radioiodine was found. (P.C.H.)

10769 ^{89}Sr, ^{134}Cs AND ^{131}I TRANSFER AND DEPOSIT INTO THE HEN'S EGG. Masaharu Oshima and Hiroshi Nozaki. Nogyo Gijutsu Kenkyusho Hokoku, Chikusan, No. 20, 225-36(May 1961). (In Japanese)

The transfer of radioactive strontium, cesium, and iodine, which were regarded as the most harmful nuclides in the radiation hazard, into the hen's egg was studied after administration of these materials to laying White-Leghorn hens. The change of the percent of doses of these nuclides transmitted into hen's egg yolk, white, and shell during 2 weeks after single intramuscular injection is illustrated, and the maximum values and total doses of the radioisotopes transferred to each part of the egg laid during 2 weeks after the injection are tabulated. The total dose of radiostrontium was the largest. Though the radiostrontium deposited mainly in the egg shell, some amount was also found in the yolk and the white. The quantity of radiocesium that moved to the hen's egg was small and was mainly in the egg white. The radiocesium content was much higher in the striated muscles than in the egg. Therefore, the contamination of the meat is more important than that of the egg in the laying hen. A consid-

erable quantity of radioiodine accumulated in the egg yolk. (P.C.H.)

10770 ELIMINATION OF ^{89}Sr FROM THE BODY IN LAYING HENS. Masaharu Oshima and Hiroshi Nozaki. Nogyo Gijutsu Kenkyusho Hokoku, Chikusan, No. 21, 1-7 (Mar. 1962). (In Japanese)

The elimination of injected ^{89}Sr from the bodies was studied in connection with egg formation in laying hens. Four laying hens that laid 3 eggs during 4 days following the injection excreted 88% of the ^{89}Sr in the egg shells, only about 0.9% being in the egg whites and yolks and 11% in the excreta. Four pre-laying hens excreted about 50% of the ^{89}Sr in the same period, the amount corresponding to 0.58 times as much as the total amount of ^{89}Sr excreted from the laying hens. In the 2nd period, between the 5th and 9th day after the injection, 4 hens had 4 eggs each. The 2 hens had continued laying about one month before and the other two began laying in this period. The total amounts of ^{89}Sr eliminated from the hens were from 6.7% to 14% of the dose in this period. About 75% of the ^{89}Sr was distributed in the egg shell, 9.4% in the white and yolk, and 15.5% in the excreta. The amounts of ^{89}Sr eliminated per day were different between the laying day and on the non-laying day. The total ^{89}Sr eliminated from the body on the laying day amounted to about 7.3 times as much as that of the preceding non-laying day. That is, the ^{89}Sr deposited in the bone would be removed effectively on the laying day in connection with the egg shell formation. However, there was little increase in the amounts of ^{89}Sr in the excreta on the non-laying day as compared with that on the laying day. As a result of the calculation, ^{89}Sr in the egg shell laid in the 2nd period corresponds to about 8.8% of the total ^{89}Sr existing in the hen's body on the laying day. (P.C.H.)

10771 GROWTH CHAMBER FOR LABELLING PLANT MATERIAL UNIFORMLY WITH RADIOCARBON. A. Andersen, G. Nielsen, and H. Sorensen (Atomenergikommissionen, Riso, Denmark). Physiol. Plantarum, 14: 378-83 (1961).

Uniform labeling of plant material with ^{14}C can be achieved by growing the entire plant during its whole growing period in an atmosphere containing carbon dioxide with a constant specific activity. Such conditions require the plant to be grown in a closed system, with an accurate and reliable control of the plant environmental factors within the unit. The growth chamber described is of a permanently fixed type and made of stainless steel. It has the shape of a box, its base being 1 × 1.5 m and the height 2 m. The back is fitted with an airtight door, the front is provided with an observation window of Plexiglas having three port holes, two of which can be fitted with gloves, the third one positioned to allow the removal of material from the chamber while under operation. Sealed service inlets and outlets are fitted to the front and back of the chamber. The top of the chamber is a glass pane above which the light sources are placed. The inorganic nutrients are provided from a solution periodically pumped up from a reservoir tank lying in the basement of the building. The lower portion of the chamber acts as a basin for this solution. Baskets containing the rooting medium (perlite) for the plants are placed in this part of the chamber and are periodically flooded by the nutrient solution. The temperature and humidity of the air in the chamber are controlled automatically by an internal air circulation system, containing cooling and heating surfaces and a set of radiators for flow of cold or hot water. The compressor and accessory machinery used for the air conditioning system are placed in the basement. The carbon dioxide concentration and the ^{14}C activity of the air in the chamber is measured, recorded, and controlled automatically. A proportional-flow counter with a very thin window is placed in the outlet vent. The count rate is recorded by a ratemeter connected to a recorder. This system can have the same function as the carbon dioxide analyzer so that it is possible by a changeover switch to decide which one of the two systems has to perform the control of the carbon dioxide production. The two systems work independently but for safety reasons are connected so that in case of a functional disturbance of one of the systems the other is able to stop the carbon dioxide production when a certain maximum concentration level has been exceeded. (BBB)

10772 WATER UTILIZATION AND CALCIUM–STRONTIUM UPTAKE IN PHASEOLUS VULGARIS. Fred H. Emmert (Univ. of Connecticut, Storrs). Physiol. Plantarum, 17: 746-50(1964).

The effect of water utilization on the uptake of ^{89}Sr and ^{45}Ca through the roots of plants was studied. Studies were also conducted with decapitated roots in which exudate flow from the cut stem end was altered by application of pressure to the surface of the ambient solution. Results showed that roots in some manner discriminated against the passage of Sr to the plant top, and that such discrimination was conditioned by water flow. Two possible explanations are cited for the water-conditioned discrimination against ^{89}Sr passage through the root. (TCO)

10773 INFLUENCE OF DIETARY SELENIUM AND AGE UPON THE METABOLISM OF SELENIUM-75 BY CHICKS. P. L. Wright and F. R. Mraz (Univ. of Tennessee, Oak Ridge). Poultry Sci., 43: 947-53(July 1964).

This study investigated the liver and kidney retention and subcellular distribution of ^{75}Se by birds which had been fed diets containing subacute levels of Se for varying lengths of time during the growing period. Growth rate and feed consumption were also studied. One-day-old White Leghorn cockerels were fed a commercial starter ration (20% crude protein) to which was added 0, 8, or 16 ppM ^{75}Se as sodium selenite. Growth rate was severely restricted by the addition of 16 ppM but only moderately at the 8 ppM level. No reductions in feed consumption were observed until after the fourth week of the experiment when the birds receiving the 16 ppM diet markedly reduced their feed intake. Chicks receiving the 8 ppM ^{75}Se diet consumed as much feed as the controls throughout the experiment even though they grew at a slower rate. The 120-hr fecal and urinary excretion of a single dose of ^{75}Se was 83% by the birds receiving the added Se compared with 32% by the controls. About 9% and 3.5% of the oral dose was in the livers and kidneys, respectively, of the controls 120 hr post dosing and 0.8% and 0.2% in these same tissues in the birds receiving the diets containing 8 and 16 ppM Se. These values were not greatly influenced by the age of the birds or the length of time they had received the Se. The intracellular particulate matter distribution of ^{75}Se in the livers and kidneys showed a characteristic pattern for each of the tissues. Both levels of added Se caused similar changes in these distribution patterns even though gross differences in tissue degeneration were apparent. The variation seen in the distribution of Se between the liver and kidneys of controls as well as the differences caused by toxic intakes of Se may indicate different metabolic pathways and reactions which Se enters into in each of these tissues. (BBB)

10774 IN VITRO STUDY OF THE BIOSYNTHESIS OF HEME AND THE INCORPORATION OF $^{14}C_2$ IN BONE MARROW OF NORMAL AND ANEMIC SUBJECTS. F. Capet-Antonini, G. Marchal, G. Bilski-Pasquier, and G. Duhamel. Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 3: 451-8(1964). (In French)

Results are reported from studies on the synthesis of heme in bone marrow aspirated from normal and anemic subjects. Glycine-^{14}C and ^{59}Fe were used as tracers. (C.H.)

10775 MEASUREMENT OF TOTAL BODY FAT IN MAN WITH ^{85}KRYPTON. F. E. Hytten (Maternity Hospital, Aberdeen, Scotland). Proc. Nutr. Soc. (Engl. Scot.), 23: XXI (1964).

A new method using ^{85}Kr was sought since most methods available for estimation of body fat in the living subject are unsatisfactory. The standard method relies on a measurement of body density and on the assumption that all adult normal humans are identical in their ratios of water, protein, and mineral, and that they differ only in possessing varying proportions of pure fat appended to the basic lean structure. This assumption, valid for small mammals, is questioned for man and definitely does not hold in states of

abnormal hydration such as pregnancy. A more direct approach is to introduce a tracer substance to the body which is soluble in body fat, like cyclopropane or ^{85}Kr. Both cyclopropane and stable krypton have already been used in a few subjects. Some subjects rebreathed Kr from a standard spirometer, but equilibration had not occurred after 7 hr. An exponential disappearance curve was assumed and the equilibration level calculated, but some of the estimates of total body fat appeared to be grossly excessive. It was shown that ^{85}Kr will never equilibrate in a system where it can escape through the water seal of the spirometer bell. Using a closed circuit with Neoprene bellows, equilibration takes about 1.5 hr for an average subject, longer for the more obese. With a spirometer volume of about 7 l, 20 μC of ^{85}Kr gives a satisfactory counting rate, and after equilibration, the average person will have taken in about 8 μC giving a total radiation dose of about 0.3 mrad. The final concentration of Kr, after equilibration, gives the krypton space of the body equivalent to: lung + mask volume (helium space) + water volume (deuterium space) × solubility in water + fat volume × solubility in fat. Four male subjects were measured and the details shown in a table. Although further technical development is required, the method appeared to be capable of giving realistic results. (BBB)

10776 DETERMINATION ON A MICRO SCALE OF CONCENTRATION AND SPECIFIC RADIOACTIVITY OF INORGANIC PHOSPHATE IONS IN WHOLE BLOOD AND PACKED RED CELLS. B. Vestergaard-Bogind (Finsen Inst., Copenhagen). Scand. J. Clin. Lab. Invest., 16: 457-64(1964).

A modified method, based upon the isobutanol–benzene extraction procedure, suitable for the determination on a micro scale of the concentration and the specific radioactivity of inorganic phosphate in samples of whole blood or packed red cells, is reported. Determination of larger series of analyses was possible, as storage of the analysis at various steps in the procedure was found permissible. The original procedure of Martin and Doty (Anal. Chem., 21: 965(1949)) was adapted to the determination of inorganic phosphate on a micro scale by decreasing all volumes by a factor of about seven. At the same time the ratio between the amount of inorganic phosphate in the sample and the resulting concentration of reduced phosphomolybdic acid was decreased by a factor of about two, thus increasing the sensitivity of the determination. The precipitation of the soluble proteins is carried out in a separate step by trichloracetic acid (TCA) rather than by silicotungstate. In the TCA-containing solution resulting from the precipitation of the proteins, spontaneous hydrolysis labile phosphate compounds will form at room temperature and it is important, therefore, to keep the temperature at about 0°C. With ^{32}P-labeled phosphate it was shown that all inorganic phosphate transferred to the extraction tube was found in the isobutanol–benzene layer after 15-sec shaking and 30- to 60-sec storage. One volume of organic phase is transferred to 4 volumes of alcoholic sulfuric acid so that a blue color developed in the course of 15 min and remained constant for about three hr. Specific radioactivity of intracellular inorganic phosphate ions was determined as follows. Supernatant, 2 × 500 μl, from two TCA precipitations of samples of packed red cells were transferred to an extraction tube containing 6 ml molybdate–silicotungstate reagent and 8 ml isobutanol–benzene mixture. After extraction and separation, samples of 500 to 2000 μl of the organic phase were transferred to the test tubes containing 4 ml alcoholic sulfuric acid and the analysis was carried out as usual. From the extraction tube a further sample of 3000 μl organic phase was transferred to a small test tube. The isobutanol–benzene was evaporated and the residue, by 2 to 4 suspensions in 200-μl portions of water, was transferred to an aluminum planchet, greased along the edge with a little silicone grease. The 200-μl portions of suspension were dried each time under an infrared lamp. The greased edge ensured that the residue was confined to a roughly circular spot in the center of the planchet, giving a reproducible geometry for the determination of the radioactivity. Relative specific radioactivity of the inorganic phosphate ions in the intra- and extra-cellular phases was determined with a standard deviation of the single determination of about 4.5%. (BBB)

10777 ROLE OF ZOOPLANKTON IN THE FRESHWATER STRONTIUM CYCLE AND INFLUENCE OF DISSOLVED SALTS. J. S. Marshall, A. M. Beeton, and D. C. Chandler (Univ. of Michigan, Ann Arbor). Verhandl. Intern. Ver. Theoret. Angew. Limnol., 15: 665-72(Feb. 1964).

The importance of certain plankton Crustacea in the freshwater strontium cycle is discussed, and the applicability of the observed ratio (OR) equation for predicting ^{90}Sr uptake by an aquatic organism was tested. A typical result from the experiments in which the ^{85}Sr content of individual Daphnia magna adults was determined at frequent intervals for a period of more than 8 days, showed that over 95% of an animal's Sr content at equilibrium is in the exoskeleton, with which it is eliminated upon molting. Other experiments showed that a first instar adult contains, at equilibrium, an average of 6.7 μg of Ca, which is equivalent to approximately 0.81% of their total live weight. It was concluded that it is quite probable that plankton Crustacea play an important role in the freshwater Sr cycle. It was also concluded that for a given species the OR is a constant. (P.C.H.)

10778 THE SYNTHESES OF ETHANE-LABELED DDT AND o-Cl-DDT AND THEIR METABOLISM IN LARVAL AEDES AEGYPTI. James Regis Hugh Duffy. Thesis, New York, Fordham Univ., 1964. 98p.

The compounds DDT-1-^{14}C, DDT-2-^{14}C, o-Cl-DDT-1-^{14}C, and o-Cl-DDT-2-^{14}C were synthesized and their metabolism studied in larvae of the yellow fever mosquito, Aedes aegypti. The ethylenic derivatives of the above compounds were also synthesized and used as reference standards for radiochromatography of the metabolic products. As a source of radiocarbon, barium carbonate-^{14}C was employed. In larval Aedes aegypti, as in adult houseflies, DDE proved to be the only detectable metabolite of DDT. Thus, the radiochromatography confirmed the results previously reported by Abedi and Brown, who used ring-labeled DDT. No water-soluble metabolites in the insect bodies or in the excreta were detected. In the larvae of Aedes aegypti, o-Cl-DDE proved to be the only detectable metabolite of o-Cl-DDT. Resistant mosquito strains were able to dehydrochlorinate o-Cl-DDT only slightly more than susceptible strains and at a lower rate than that at which they dehydrochlorinated DDT. No water-soluble metabolites of o-Cl-DDT were found in the insect bodies or excreta. DMC proved to be synergistic with DDT and o-Cl-DDT for resistant, but not for susceptible strains of mosquito larvae. The production of DDE and o-Cl-DDE by resistant strains was reduced by DMC, which also appeared to have the effect of reducing the absorption of DDT and o-Cl-DDT. (A.G.W.)

10779 A MICRO-METHOD FOR SPECIFIC ACTIVITY ANALYSIS OF ^{131}I-LABELED TYROSINE DERIVATIVES AND ITS USE IN THYROID HORMONE BIOSYNTHESIS. A. Van Zyl and B. Wilson (Univ. of Cape Town). p.226-41 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

A method is described for the measurement of specific activities of ^{131}I labeled monoiodotyrosine (MIT), diiodotyrosine (DIT), thyroxine (T_4), and triiodothyronine (T_3) and free iodine, which can be performed simultaneously on one rat thyroid gland. The same method can be used for specific radioactivity analyses of chemically labeled tyrosines and thyronines. Examples are given of the use of this method in studying the time for isotopic equilibrium of ^{131}I in tyrosines and thyronines and for its use in the elucidation of metabolic pathways in the biosynthesis of tri-iodothyronine and thyroxine. The results so far indicate little difference in the absolute specific activity of thyroidal MIT/DIT ratios from 10 seconds to 90 minutes and from 2 to 48 hours after intravenous or intraperitoneal injections of ^{131}I in rats although the specific activities of MIT are not equal to those of DIT. They also confirm the theory of thyroxine forma-

tion from the coupling of 2 molecules of diiodotyrosine and indicate a greater probability of triiodothyronine formation from the coupling of mono- and diiodotyrosine than from deiodination of thyroxine. Examples of changes in μ molar activities of mono- and diiodotyrosine, thyroxine and triiodothyronine in rat thyroid glands are given at different intervals after ^{131}I injections and at a constant interval but with a variable dose of ^{131}I ranging from 50 to 400 μC. The application of these and related findings to thyroid hormone biosynthesis is discussed. (auth)

10780 THE EFFECT OF PLACEMENT OF ^{32}P-LABELLED SUPERPHOSPHATE, AND OF RADIATION AND NITROGEN ON THE NUTRIENT UPTAKE OF ERAGROSTIS CURVULA (SCHRAD.) NEES. A. B. Bridgens (Erstwhile Div. of Crops and Pastures, Pretoria) and T. P. Pretorius. p.403-28 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Eragrostis curvula was grown from seed in rows, three feet apart, on a deep loamy sand. Superphosphate labeled with ^{32}P (5.55 mC per lb of fertilizer) was inserted into the soil at various depths below and between the rows. Within a period of 32 days of sowing, the roots of the young grass had begun to take up phosphorus from depths of 18 inches between the rows, and 36 inches below the rows. The uptake of fertilizer P by the grass was greatest where the placement of the superphosphate was shallow. Depth of placement affected the K content of the herbage and modified the effect of a top-dressing of sulfate of ammonia on the fertilizer P, total P, and Mg content of the herbage. Ammonium sulfate increased the fertilizer P uptake by the grass, reduced the Ca and Mg content of the herbage, and increased its N content. Radiation from 500 lb of labeled superphosphate per morgen reduced the total P uptake by the eragrostis in the absence of applied ammonium sulfate. In the presence of 1000 lb of applied ammonium sulfate, which itself reduced the total P uptake, the depressive effect of radiation was not significant. Where the quantity of labeled superphosphate applied per morgen was increased from 500 to 3000 lb, no effect of radiation on either the yield or the total P content of the herbage was observed. (auth)

10781 A DISTRIBUTIONAL BASIS FOR THE VARIATION IN KILLING EFFICIENCIES OF DIFFERENT TRITIATED COMPOUNDS INCORPORATED INTO E. COLI. Arthur L. Koch (Univ. of Florida, Gainesville). 17p. (CONF-556-11).

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

The decay of tritium incorporated as thymidine into the DNA of bacteria is known to be more lethal than is the decay from tritium incorporated as uridine, leucine, or histidine. To what extent these differences can be attributed to different degrees of irradiation of the DNA of the cell resulting from different cellular distribution of these components is considered. Several cases are considered for the absorption characteristics of the tritium β radiation. In one case it is assumed that the tritium β rays travel in straight lines indefinitely and with uniform deposition of energy along the paths. In a second case, exponential attenuation is assumed. Calculations are presented for an idealized bacterial cell that has a radius of 1.0 μ and a radius of the DNA in a concentric sphere of 0.5 μ radius. For illustration, taking the factor of 3.65, which corresponds to an inverse dependence on 1.87th power of the radius instead of the 2.0 power, and further taking 2.8 to be the ratio of efficiencies of killing of a DNA and the protein labels, then it was calculated that the radius of nuclear body is 0.576 that of the cell and that its volume is 19.2% that of the cell. (P.C.H.)

Radiation Effects

Refer also to abstracts 10741, 10761, 11616, and 11622.

10782 (BNL-8787) RADIATION AND FIRE EFFECTS ON GAYLUSSACIA BACCATA AND VACCINIUM VACILLANS (thesis). Robert Duncan Brayton (Brookhaven National Lab., Upton, N. Y.). Jan. 1965. Contract AT-30-2-GEN-16. 37p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Submitted to Rutgers Univ.

A study was made of the effects of fire and γ radiation on the natural growth responses of Gaylussacia baccata and Vaccinium vacillans. Results indicate that both fire and ionizing radiation appear to affect bud mortality in these two shrub species. The differential sensitivity of the buds of these two species, as well as the number of buds capable of initiating shoots after damage, appear to account for their differential survival and resultant shrub layer structure and composition in damaged communities. The intensity of damage appears to be more important than kind. Evidence indicates that cumulative shrub layer damage is possibly due to the balance struck between bud mortality versus either regeneration or survival or both. The number of buds remaining after damage and the opportunity for their development with consequent renewal of the supply of perennating buds appear to be highly significant to the survival and success of these two species in damaged communities, regardless of the agent. (auth)

10783 (COO-119-231(p.76-84)) THE EFFECTS OF IONIZING RADIATIONS ON ENDOCRINE CELLS. IV. INCREASED PRODUCTION OF 17α, 20α-DIHYDROXYPROGESTERONE BY RAT TESTES AFTER IRRADIATION. David L. Berliner and LeGrande C. Ellis (Utah. Univ., Salt Lake City. Coll. of Medicine).

Rat testicular mince was incubated with progesterone-4-^{14}C. From the incubation mixture, 17α,20α-dihydroxyprogesterone was isolated and characterized as one of the main steroids of the high-polar steroid fraction. The biosynthesis of this steroid was shown to be altered after x irradiation. When 17α,20α-dihydroxyprogesterone was incubated with mouse testicular tissue, only small amounts of this steroid were biotransformed into 17α-hydroxyprogesterone, androstenedione, and testosterone. These data indicate that an accumulation of a non-androgenic steroid occurs after direct irradiation to the testes. (auth)

10784 (NYO-2564-1) THE EFFECT OF IONIZING RADIATION ON THE METABOLISM OF STRAIN L. Terminal Report, May 1, 1960–July 31, 1964. Roland M. Nardone (Catholic Univ. of America, Washington, D. C.). Contract AT(30-1)-2564. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are summarized from a series of studies on the effects of doses of γ radiation ranging from 100 R to 2500 R on the multiplication, gross cytology, and the synthesis of total protein, nucleic acids, and amino acids in single cells or isolated nuclei of L cells in tissue cultures. Carbon-14, tritium, and ^{35}S were used as tracers to follow the metabolism of glucose, methionine, glycine, uracil, histidine, and thymidine in the irradiated cells. Results showed that it is difficult to determine radiation effects immediately after exposure. The first noticeable effect was a prepro-phase arrest with concomitant drop in number of mitotic cells. The radioinduced lengthening of mitotic phases was more evident 24 hr after irradiation that at 72 hr, and generation times were longer in second generation cells than in fourth generation. It was concluded that once the mechanisms necessary for recovery from radiation injury were activated the cultures were able to survive and show a dose dependent response. (C.H.)

10785 (RADC-TDR-63-352) MICROWAVE MODIFICATION OF X-RAY LETHALITY IN MICE. R. A. E. Thomson, S. M. Michaelson, and J. W. Howland (Rochester, N. Y. Univ.). Aug. 1963. Contract AF30(602)-2921. 9p. (AD-424411). $1.60(OTS).

Fourteen and thirty days after mice received 2800 Mcycles/sec, pulsed microwave treatment they were subjected to 250 KVP whole-body x irradiation at dose levels of 700 R, 800 R, and 900 R. These dose levels are the thirty day LD30, LD75, and LD95 values for normal mice. Evidence of reduced lethality and tendency for longer survival times in the microwave-pretreated mice compared with that of normal x irradiated mice is presented. (auth)

10786 (TID-21440) ACUTE BRAIN DAMAGE INDUCED BY X-IRRADIATION. 1. CYTOCHEMICAL AND BIOCHEMICAL STUDIES OF NEUROGLIAL NUCLEIC ACIDS. Final Progress Report, April 23, 1964–July 31, 1965. Robert H. Brownson (Medical Coll. of Virginia, Richmond). Contract AT(40-1)-2904. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Fluorescent microscopy and direct tissue electrophoresis were used to study the effects of direct head x irradiation on cells of the central nervous system of cats and rats. Results indicated that irradiated pyknotic cells of the corpus callosum were resistant to depolymerization by DNAase and to hydrolysis by HCl. It was concluded that this indicates radioinduced resistance of DNA to depolymerization by a change of molecular configuration. Differences were observed in the electrophoretic patterns of x irradiated and control corpus callosum. Numerical counts of the nuclei in cells from 1 to 46 hrs after x radiation exposure showed a definite increase in pyknotic cells immediately after irradiation with a decrease as the hours from the exposure time increased. It is postulated that this could indicate a possible recovery of the nuclei from the effects of x radiation. (C.H.)

10787 (TID-21581) STUDIES OF THE EFFECTS OF ULTRAVIOLET RADIATION ON CELL STRUCTURE AND BEHAVIOR. Annual Progress Report, January 1963–November 1964. Jerome J. Freed (Institute for Cancer Research, Philadelphia). Jan. 21, 1965. Contract AT(30-1)-2356. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A vibrating mirror flying spot microscope is described that was designed and constructed to measure ultraviolet absorbancy of single living cells in culture and to display the absorbancy of the specimen as a television image on a synchronized television display tube. The equipment gave good results in studies of structural and metabolic mechanisms involved in the control of cytoplasmic motility as observed in tissue cultures. It was found that measurements could be made at dose levels low enough to avoid damage to the cell and the normal increase in absorbancy through interphase could be recorded. Preliminary results are reported from studies on isolated rat liver nuclei; measurements of the cell growth-duplication cycle of hamster cells growing in uv-transparent medium; the effects of puromycin, a protein synthesis inhibitor, on HeLa cells grown in perfusion chambers; inclusion bodies in fixed preparations of HeLa cells; the effects of colchicine, a mitotic inhibitor, on the saltatory movement of cytoplasmic particles during interphase of HeLa cells in culture; and genetic studies on haploid and diploid embryo cells of Rana pipiens and Rana sylvatica in culture. (35 references.) (C.H.)

10788 (TID-21584) TERMINAL REPORT [ON CYTOLOGICAL, PHYSIOLOGICAL AND GENETIC PROBLEMS IN T. PYRIFORMIS]. Carolyn Wells (Longwood Coll., Farmville, Va.). Dec. 15, 1964. Contract AT(40-1)-2793. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are summarized from cytologic, physiological, and genetic studies of the ciliate, Tetrahymena pyriformis. Data on the radiosensitivity of T. pyriformis are included. No recessive lethals were induced by x radiation in this organism. (C.H.)

10789 (TID-21591) PROGRESS REPORT [ON MECHANISM OF LETHAL AND MUTAGENIC ACTION OF IONIZING RADIATION IN E. COLI AND YEAST]. (Institut Pasteur, Paris). 1964. Contract AT(30-1)-2803. 11p. Dep.(mn); $1.00(cy), 1(mn] OTS.

Progress is reported in studies on the effects of x radiation on genetic recombination in Escherichia coli, identification of the cellular site of the mutagenic action of x radiation and ultraviolet radiation in E. coli, the induction of a lysogenic strain of E. coli by 5-fluorouracil, and the mechanism of lethal and mutagenic actions of x radiation in Saccharomyces cerevisiae. A list is included of publications during the period. (C.H.)

10790 (TID-21601) MUTATION RATES AT SPECIFIC AUTOSOMAL LOCI IN DIFFERENT SPECIES OF DROSOPHILA. Final Report Covering Five Years, 1959–1964. Aloha Hannah-Alava (Turku, Finland, Univ.). Contract IAEA 31/US. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are summarized from a series of studies on the effects of x radiation on mutation frequencies in Drosophila melanogaster. Emphasis was placed on spermatogonial mutation rates resulting from irradiation of specific third-chromosome loci of cells in different stages of maturation. Frequencies for third-chromosome recessive lethals were also determined. Data are presented, based on 7 replicates and totaling 42,115 F_1 offspring in 7 broods covering a period of 20 days following exposure of the male parents to 3000 R x radiation, that indicate that the pattern of recovery of the visible mutations in the spermatogonial broods was different from the recovery of the third-chromosome recessive lethals. Data from a second experiment, based on 51,954 offspring in 20 broods covering a period of 24 days following exposure of the male parents to 3000 R x radiation, indicate that the difference is due to a difference in recovery rather than sensitivity. (C.H.)

10791 (TID-21608) THE BROOD-PATTERNS OF MUTATIONS AND CROSSING-OVER RECOMBINANTS IN SUCCESSIVE BROODS OF F_1 OFFSPRING FROM MALES TREATED WITH 3000 r OF X-RAYS. Period Covered: November 1, 1959–October 31, 1964. Aloha Hannah-Alava (Turku, Finland, Univ.). Contract 31/US. 3p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are reported from studies on the frequencies of induced chromosome crossing-over recombinations and three types of visible mutations in successive broods of offspring from Drosophila melanogaster males that had been treated with 3000 R of x rays and mated to females with appropriate third-chromosome markers for detecting mutations and/or crossing-over recombinants. (C.H.)

10792 (JPRS-28345) THE EFFECT OF THE METHODS OF VICASOL ADMINISTRATION ON THE GROWTH AND RADIOSENSITIVITY OF TUMORS. S. A. Baysheva. Translated from Vest. Akad. Nauk Kaz. SSR, No. 9, 74-6 (1964). 6p. (TT-65-30149). $1.00(OTS).

Vicasol, an analog of vitamin K, enhanced the radiosensitivity of transplanted tumors growing in rats. Best results were obtained after intra-tumoral administration but fair results were obtained after intraperitoneal administration. Subcutaneous administration of vicasol did not change the effects of radiation. Results are presented from studies on rats with subcutaneous transplants of sarcoma-45, Walker's carcinosarcoma, alveolar cancer of the liver, and Pliss lymphosarcoma. (C.H.)

10793 ON THE EFFECT OF ENERGY-RICH IONIZING RADIATION ON LIVER AND KIDNEY DEIODASE. P. Georgi and W. Nowak (Ernst-Moritz-Arndt Universität, Greifswald, Ger.). Acta Biol. Med. Ger., 13: 144-8(1964). (In German)

Two groups of 6 guinea pigs each were given 299 and 400 μC of carrier free ^{32}P subcutaneously. Six weeks later the enzymatic activity of the liver deiodase was measured in these animals and compared with that from 10 control, uninjected animals. There were no significant differences in enzymatic activities between the three groups. Other additional groups of guinea pigs were irradiated with 100 R of 200-kv x ray, and the activity of the enzyme was measured 15 min and 30 days later. No differences were found between the groups at this radiation level. After irradiation of guinea pig liver and kidney in vitro with 28000 and 56000 R of 200-kv x ray no marked changes in the deiodase activity could be detected compared to control samples. Enzymatic activity of kidney deiodase was increased slightly after 200 μC of ^{32}P was administered to guinea pigs, but the difference, compared to kidney deiodase activity in uninjected control animals was more definite after 400 μC had been given. These results varied sharply from the decreases in activity of the enzyme previously reported after administration of ^{131}I. (BBB)

10794 OTOCEPHALY AFTER IRRADIATION OF MOUSE EMBRYOS IN UTERO. J. Van Der Borden (Universiteit, Amsterdam). Acta Morphol. Neerl.-Scand., 6: 105(1964).

Mouse embryos were x irradiated in utero on the 8th day of pregnancy. Two to four days after irradiation with 400 R, 4% of the fetuses showed otocephaly (synotia) of the inner ear, besides severe malformations of the brain. Deformities of the rhombencephalon play an important role in the origin of this abnormality. Dependent on differences in sensitivity between the various embryos but also between different parts of the neural tube, a proliferative process of the neural epithelium develops in the alar lamina and after severe damage also in the basal lamina. When proliferation proceeds, the excessive neuroepithelium disintegrates, resulting in a local destruction of the neural tube. If this loss of tissue, especially of the dorsal parts, takes place at the critical moment and at a sensitive spot, it may cause a fusion of originally paired organs. In this way in many embryos the geniculate ganglia fused, while others showed otocysts united at the dorsal side of the neural tube. As the underlying rhombencephalon diminishes, the size and differentiation of the unpaired otocyst decreases accordingly, but only the largest otocyst shows a double cochlea and vestibulum. The endolymphatic duct, however, is unpaired and medially situated, its size being about twice normal. On the other hand, the smallest otocyst does not show any differentiation. (BBB)

10795 THE EFFECT OF WHOLE-BODY RADIATION ON THE HEMODYNAMICS AND THE ELECTROCARDIOGRAM OF THE DOG. Karl Kluetsch, Hans Hochrein, Heribert Braun, and August Heidland (Universität, Würzburg, Ger.). Aerztl. Forsch., 17: 646-50(Dec. 10, 1963). (In German)

Ten dogs were anesthetized and irradiated with 250-kv x ray for a period of ~4 hr. The radiation dose administered totaled 800 R and was given at a constant rate of 200 R/hr. Blood pressure, heart rate, and electrocardiograms were measured throughout the experimental period. The systolic blood pressure fell from an average of 175 mm preexperimentally to a final value at the end of the irradiation of 154 mm. Diastolic blood pressure fell from an average initial value of 104 mm to a final value of 82 mm. The average heart rate did not change appreciably, ranging between 173 and 182 beats/min. The average total blood volume and the circulation time remained essentially unchanged during the irradiations. The irradiations did not perceptibly influence the characteristics of the electrocardiograms. (BBB)

10796 PERSISTENT STUNTING FOLLOWING X-IRRADIATION OF THE FETUS. Roberts Rugh, Lyse Duhamel, Alan W. Osborne, and A. Varma (Columbia Univ., New York). Am. J. Anat., 115: 185-97(July 1964).

The effects of the radiation dose level and the prenatal stage at irradiation on the degree of radioinduced stunting were assessed using a standard dose of x rays (100 R) at each of the prenatal stages from 0.0 through 18.0 days gestation, as determined on four-month-old adult mice. Using such a standard dose of x irradiation it was possible to establish the prenatal stages when the skeletal primordia are particularly radiosensitive. CF1 female mice were time-mated and the embryos at each gestation day were irradiated. The young were observed for four months at which time a radiographic skeletal study was made. With the 100-R dose the litters were reduced in size, following irradiation at certain gestation ages, and there was increased neonatal mortality so that the skeletal study was based only upon the survivors to four months and represents the maximum development under the conditions of irradiation. The sex ratio was not altered by irradiation. The skeletal measurements, taken from 1005 radiographs of the living animals and averaged for each gestation day, showed sex differences in stunting, even when x irradiation occurred before day 9.0. The highest statistical significance in skeletal effects was between 11 and 13 days, when the embryo showed the earliest skeletal differentiation. Such mice were topographically well developed and free of abnormalities. The implications of these findings to the evaluation of the hazards of diagnostic radiologic exposure of human embryos and fetuses are discussed. (TCO)

10797 AMYLOIDOSIS AND LYMPHOID APLASIA IN MOUSE RADIATION CHIMERAS. S. Bradbury and H. S. Micklem (Dept. of Human Anatomy, Oxford and Medical Research Council, Harwell, Berks, Eng.). Am. J. Pathol., 46: 263-77(Feb. 1965).

Splenic and hepatic hyaline deposits occurred frequently in mouse radiation chimeras suffering from secondary disease. The staining characteristics, histochemical reactions, and ultrastructure of these deposits showed them to be of an amyloid nature. The material contained protein, at least two carbohydrate components, one of which was a sulfated mucopolysaccharide, and lipid (which is not a regular constituent of human amyloid). Lipid-laden macrophages were numerous in amyloidotic spleens, but not in the spleens of normal healthy mice. There was no evidence that the protein portion of the amyloid material was synthesized locally. Profound lymphoid hypoplasia or aplasia was seen in all mice with amyloidosis. Hyperplasia of the granulocytic series, in both bone marrow and splenic pulp, was usually present, and there was often an unusually massive proliferation of plasmacytes in the mesenteric lymph node. If the development of lymphoid hypoplasia was prevented by an injection of viable, antigenically compatible lymph node cells from adult donors, the incidence of amyloidosis and granulocytopoietic hyperplasia was very significantly reduced. Plasmacytic hyperplasia in the lymph nodes was also reduced. (auth)

10798 IRRADIATED BONE GRAFTS. Leonard Marmor (Univ. of California Medical Center, Los Angeles). Am. J. Surg., 107: 833-6(June 1964).

The radiosterilization of human bone and its use in surgical replacement of diseased bone are discussed. Cathode irradiation of bone grafts was used. The grafts were obtained at postmortem examinations or from operative specimens within six hr and cut into suitable size for packaging in three sealed polyethylene bags for additional safety. The grafts were immediately frozen and irradiated. Cultures were taken from a control package, and if these were reported negative at one week for anaerobic and aerobic bacteria, the bone was released from the bank. Bone can be stored in this manner for six months at −20°F. Up to the present, 714 bone grafts have been utilized in surgical procedures. This review covers 101 patients in whom 329 bone grafts were used. The bone was supplied to a number of surgeons throughout the area. Grafts were packed in dry ice and were mailed by air express to various parts of the state for use in a variety of procedures. In these 101 patients, the rate of success of the operations in which bank bone was used was 92%. The lesion that had the highest rate of success was the unicameral bone cyst. There were no infections due to bone grafts at this medical center, but three cases were reported by surgeons elsewhere. However, there is a reasonable doubt that the bone played any role in the infections. It is concluded that frozen irradiated bone is an excellent source of preserved bone for grafts in man, and lends itself well to the establishment of a bone bank in any hospital. The bone can be prepared locally and flown to a major center for sterilization and then shipped throughout the world. The results are very encouraging in the majority of surgical procedures. The bone has made possible early operations in children which would have been otherwise impossible. (BBB)

10799 RESPONSE OF 3 BREEDS OF SWINE EXPOSED TO WHOLE-BODY COBALT-60 GAMMA RADIATION IN DAILY DOSES OF 100 ROENTGENS. D. G. Brown, W. A. Gramly, and F. H. Cross (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Am. J. Vet. Res., 25: 1347-53 (Sept. 1964).

Ninety pigs were used, consisting of 3 breeds (Yorkshire, Hampshire, and Duroc) and 2 breeding lines within each breed. The swine were exposed to ^{60}Co γ radiation in daily doses of 100 R until death, the time for each daily exposure being ~3 hr. The following clinical signs are listed after the dose accumulated: 400 R, the swine were less active, reluctant to move, and had decreased appetities; 700 R, drooping of back which persisted for 3 days; 800 R, blood-tinged stools, slight incoordination in hind parts, and

variable soreness in muscles; 900 R, stiff gait; 1000 R, erythemia, swollen joints, and incoordination; 1100 R, hemorrhage from rectum; 1200 R, hematuria (infrequently); 1400 R, hemorrhage from mouth, dyspnea, diarrhea, grinding of teeth, and a 1 to 2°F rise in rectal temperature; 1500 R, watery diarrhea with thick, stringy mucus; 1800 R, vomiting, pronounced incoordination, and soreness of shouiders; 1900 R, painful joints, lameness, and purpura and petechia in the cutis; 2200 R, infrequent convulsions; 2300 to 4300 R, weakness was progressive; diarrhea and lameness subsided after 2300 R. The mean survival times for each breed (and for lines within breeds) were: Duroc, 16.8 days (15.4 and 18.3); Hampshire, 22.6 days (19.5 and 25.8); and Yorkshire, 28 days (25.6 and 30.4). The principal lesions or conditions and incidence observed at necropsy were disseminated hemorrhages (95%), mostly in the respiratory digestive, urinary, and lymphatic systems; bronchopneumonia (70%); fibrinous pleuritis (40%); pericarditis (30%); hemorrhagic gastroenteritis (40%); ulcerative gastritis (15%); ulcerative proctitis (30%); necrotic proctitis (15%); and jaundice (10%). The bacteria most frequently isolated from the various organs and cerebrospinal fluid were Pasteurella multocida, α and β hemolytic Streptococcus, and Escherichia coli (occasionally Staphylococcus, Clostridium, Proteus, and Pseudomonas). The highest incidence of infectious lesions was seen in swine which survived longest. Hematologic changes are described in detail. Changes in lymphocyte and granulocyte counts were similar in the three breeds. Lymphocytes, without exception, disappeared from the peripheral blood of all animals at a precipitous rate within several hours after a single exposure of 300 R or higher. On the other hand, granulocytes, particularly neutrophils, temporarily increased immediately after a single exposure and then decreased at a relatively uniform rate thereafter. Low granulocyte counts were considered more significant in irradiation deaths than low lymphocyte counts. The hematologic and other clinical changes were similar between breeding lines within each breed, although the difference in mortality between breeding lines was large, as well as between breeds. The differences in hematologic changes among the breeds offered little toward an understanding of the difference in mortality. These results indicate that the physiologic or genetic characteristics associated with survival are capable of being altered through selective breeding. One Hampshire gilt which survived the experiment (4300 R) farrowed two litters of pigs, 9 months (7 healthy pigs) and 18 months (six healthy and two dead pigs) after termination of irradiation. Although this one pig which survived was a female, the response of each sex was similar in all parameters measured. (BBB)

10800 SURVIVAL OF ISOLATED INSECT TISSUES FOLLOWING RADIATION. Wesley Larsen (College of Southern Utah, Cedar City). Ann. Entomol. Soc. Am., 56: 720-1(Sept. 1963).

Radiation effects on the survival of isolated tissues from embryos of the cockroach Blaberus craniifer Burmeister were investigated. A series of 24 hearts was given dosages of x irradiation varying from 1000 to 12,000 Roentgens. All except 6, that had not succumbed to bacterial infection, continued to live and contract for 150 days after the treatment. Whole embryos and adults have a lethal point of about 7000 R. Another series of 22 hearts, 11 clusters of Malpighian tubules, and 11 portions of hindgut was treated with ^{60}Co dosages up to 93,000 Rads. The tubules continued to pulsate for 15 days, hearts to beat for 23 days, hindguts to carry on gross movements for 60 days after maximum treatments. It was concluded that the extreme resistance to gamma radiation is due to very low oxygen requirements of these tissues. (P.C.H.)

10801 THE MEASUREMENT OF RESIDUAL ACUTE INJURY FROM SINGLE EXPOSURE BY SURVIVAL FOLLOWING DAILY IRRADIATION. Douglas Grahn and George A. Sacher (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 114: 158-68(Mar. 31, 1964).

A method for examining recovery kinetics was developed and is presented. The results of the method were compared with certain existing data, and some of its advantages and disadvantages are discussed. The method is called the daily-dose method. Independent samples of animals are first subjected to different single whole-body doses of radiation (the initial, conditioning or insult dose), then, after some chosen time interval, all the samples are exposed to a constant daily dose of gamma radiation for the duration of life. The daily exposure level is chosen to cause a selected acute or subacute radiation syndrome, wherein death occurs between about 15 and 120 days from the start of exposure. The mean after-survival (MAS) from the start of daily exposure is the endpoint statistic. The most severe disadvantage is the lack of definition of the time variable though this can be overcome by providing at least one set of base-line paired-dose estimates. (P.C.H.)

10802 DIRECT ACTIONS OF ULTRAVIOLET AND X RAYS ON GROWTH IN VITRO OF NERVE FIBERS OF IRRADIATED CHICKEN EMBRYO MARROW. Jean-Pierre Denefle and Raoul Michel May (Faculte des Sciences, Paris). Arch. Anat. Microscop. Morphol. Exptl., 49: 395-409(1960). (In French)

Seven-day-old chicken embryo marrow was exposed to uv or x radiation to determine their effects on the external growth of the medullary nerve fibers. The 24-hr cultures of fibers irradiated with uv rays of 3003-Å wavelength showed a quantitative and qualitative stimulation of neurite growth for exposure time up to 90 min, 7 cm below the source. Neurite growth was inhibited progressively by exposures longer than 90 min. After exposure time of 15 to 90 min the cultures showed 60% optimal growth compared to 45% for the controls. After 90 to 150 min the cultures averaged 19% optimal growth compared to 49% for the controls. Nerve fibers cultured for 24 hr after irradiation at 3400- or 3825-R doses were generally longer than the controls, but the latter showed 48 to 57% optimal growth. At 3400 R there was 27% optimal growth, but most neurites showed vesicular degeneration, alveolation of the plexuses, and accelerated movement of the intraspherular granules and terminal and lateral digitations. At 3825 R there was 10% optimal growth, most fibers showing granular degeneration and inertia. A 24-hr culture of marrow irradiated with 4500 R had short fibers, numerous spherules and granules, and many nonadjoining neuroplasmic regions. X irradiated fibers degenerated faster than control fibers, proportionately to the dosage received. (BBB)

10803 BIOSYNTHESIS OF L-ASCORBIC ACID IN RAT LIVER MICROSOMES: INFLUENCES OF AGE, SEX, DIETARY CHANGES, AND WHOLE-BODY X-IRRADIATION. I. B. Chatterjee and Ralph W. McKee (Univ. of California, Los Angeles). Arch. Biochem. Biophys., 109: 62-7(Jan. 1965).

The activities of the liver microsomal enzymes in rat, namely, D-glucurono reductase, L-gulono dehydrogenase, and L-gulono oxidase, which convert D-glucuronolactone and L-gulonolactone into L-ascorbic acid, are very low in the embryonic stage. The activity increases after birth, attains a maximum on the 14th day, and then falls. Besides the effect of age, sex has also some influence on the biosynthetic capacity. Starvation or injection of L-ascorbic acid in rats results in a marked decrease in the enzymic activity of the liver microsomes. The biosynthetic capacity is also impaired after a lethal dose of whole-body x irradiation, but this impairment again is caused by inanition rather than by a specific effect of x irradiation. The results indicate that very probably those enzymes are adaptive enzymes. (auth)

10804 LATE PRIMARY HYPOTHYROIDISM IN X-IRRADIATED DOGS. Myron I. Varon (Univ. of Rochester, N. Y.). Arch. Environ. Health, 10: 46-52(Jan. 1965).

The pathological development of clinical hypothyroidism in relation to long-term vasculoconnective tissue changes leading to secondary effects in an organ generally considered radioresistant was studied in beagles given 970, 1215, 1820, and 2125 R upper-body x irradiation. Evidence is presented supporting involution secondary to effects on vasculoconnective tissue as the pathogenic mechanism. Histological examination of human thyroid glands in older

age groups indicated that vasculoconnective changes in the aging thyroid were attributable to a primary aging effect rather than to an effect of decreased demand. It is suggested that the failure of supporting stroma and vasculature to support the metabolic demands of parenchymal tissue cells may play a significant role in the late effects of ionizing radiation as well as in the physiological process of aging. (H.M.G.)

10805 ON THE CHEMICAL ALTERATION OF THE RADIOSENSITIVITY OF VARIOUS EXPERIMENTAL TUMORS. R. Koch and I. Seiter (Universitat, Freiburg i. B.) (Arzneimittel-Forsch., 14: 1018-21(Sept. 1964). (In German)

The protective effects of various radiation protection substances were tested in vitro against Ehrlich ascites cells, and in female mice against transplanted reticulum cell sarcoma or Crocker 180 mouse sarcoma cells. In vitro the substances tested included 6-aminonicotinic acid amide, monoiodoacetic acid, and Synka-Vit, a proprietary preparation of tetrasodium-2-methyl-1,4-naphthohydroquinone diphosphate. The mixtures of these chemicals with the ascites cells were irradiated with 20000 R of x ray. The mice were treated individually with intraperitoneal injections of cysteamine (3 mg), serotonin creatine sulfate (1 mg), thiourea (40 mg), nicotinic acid amide (2 × 10 mg), and Synka-Vit (5 × 1 mg). The time of administration relative to the time of irradiation of the tumor area varied within a few minutes of the treatment. The tumor was directly irradiated with 5000 R. In vitro the 6-aminonicotinic acid amide and the Synka-Vit exhibited a definite radiation protective effect on the ascites tumor cells, but the monoiodoacetic acid had no effect. In vivo cysteamine had no effect on the reticulum cell sarcoms. Cysteamine, nicotinic acid amide, and Synka-Vit had some protective effect when the Crocker sarcoma was irradiated, but serotonin and thiourea had no effects. (BBB)

10806 THE CARCINOGENIC EFFECTS OF IONIZING RADIATION. A REVIEW OF CURRENT PROBLEMS. Yu. I. Moskalev and V. N. Streltsova (Inst. of Biophysics, Moscow). At. Energy Rev., 2: No. 3, 149-94(1964).

Included in the review on carcinogenic effects of radiation are: analyses of the distinctive characteristics of the carcinogenic effect of external and internal sources of ionizing radiation depending on the radiation conditions and the organs or tissues involved; the role of the time factor; the mechanisms by which tumors occur and the dose-effect; and threshold problems. A number of new theses are advanced, principally with regard to the dose-effect and threshold problems. Data are given on the comparative effects of various isotopes. 209 references are included. (P.C.H.)

10807 EFFECTS OF IONIZING RADIATIONS ON SERUM COMPLEMENT. Alfredo Begliomini, Alessandro Gubbiotti, Duilio Massa, and Armando Morozzi (Istituto Zooprofilattico dell'Umbria e delle Marche, Perugia, Italy). Atti Soc. Ital. Sci. Vet., 16: 5p.(Oct. 1962). (In Italian)

Data are presented on the effects of exposure to doses of ^{60}Co γ radiation ranging from 25,000 to 3,000,000 Rads on aqueous dilutions of serum complement ranging from 1 to 100%. (C.H.)

10808 EFFECTS OF IONIZING RADIATIONS ON ANTI-SHEEP HAEMOLYTIC SERUM. Alfredo Begliomini, Alessandro Gubbiotti, and Duilio Massa (Istituto Zooprofilattico Sperimentale dell'Umbria e delle Marche, Perugia, Italy). Atti Soc. Ital. Sci. Vet., 16: 3p.(Oct. 1962). (In Italian)

Data are presented on the effects of exposure to doses of ^{60}Co γ radiation ranging from 30,000 Rads to 1 MRad on hemolysins in antisheep hemolytic serum diluted from 1:10 to 1:4000. (C.H.)

10809 AUTOLYSIS OF NUCLEIC ACIDS OF BONE MARROW IN NORMAL ANIMALS AND AFTER ROENTGENOGRAPHIC IRRADIATION. G. A. Krit-skii, R. N. Safronova, L. A. Chil-Akopyan, and Yu. T. Kovtun (Bakh Inst. of Biochemistry, Moscow). Biochemistry (USSR) (English Transl.), 28: 484-9(July-Aug. 1963). Translated from Biokhimiya, 28: 595-601(July-Aug. 1963).

The change in autolysis of DNA and RNA in bone marrow homogenates in the early period after local roentgenographic irradiation of rabbit extremities were studied. It was shown that immediately after local irradiation with a dose of 200 R and higher, the shallow autolysis of DNA is activated. Immediately and in the hours just after irradiation with 2000 R, the initial rate of DNA autolysis is increased almost three fold. Deep autolysis of DNA in which about 50% of the DNA is split does not differ from the normal in the period immediately after irradiation. Activation of RNA autolysis appears only about two hours after irradiation with 2000 R. After a day and in later days after irradiation there is considerable inhibition of DNA and RNA autolysis. The maximum inhibition appears in 2 to 4 days after which the rate of autolysis gradually approaches the normal. Ten days after irradiation with a dose of 2000 R, the autolysis of the nucleic acids remains considerably below normal. Change in autolysis of nucleic acids compares with changes in their content. Activation of DNA autolysis shows earlier radiation damage than decreased content of nucleic acids or change in content of free nucleotides. Activation of DNA autolysis at once, and in the hours following irradiation can show characteristic and significant radiation biochemical damage, leading to disruption of the cell. The sharp inhibition of autolytic splitting of DNA and RNA in the days following irradiation can be explained by the qualitative changes of DNA and RNA in the irradiated tissue. (auth)

10810 ON THE CHANGES IN THE VASCULAR ELASTIC FIBERS IN RABBIT AURICLE SUBJECTED TO CERVICAL SYMPATHECTOMY BEFORE TREATMENT WITH Co-60. R. Balli and U. Perucci (Università, Modena, Italy). Boll. Malattie Orecchio, 80: 266-70(May-June 1962). (In Italian)

Experiments were performed to study the changes induced by radiation on vascular elastic fibers and to determine the role of the sympathetic nervous system in the physiopathology of these changes. Left cervical sympathectomy was performed on rabbits, and a week later, the auricles were exposed to radiation from a telecobalt therapy unit. One half of the rabbits were irradiated every second day and the other half every day with single doses of 410 R. The groups were divided into subgroups that received total doses of 1640, 3500, or 5500 R. The animals were sacrificed 30 days after the total doses were reached and both auricles were histologically studied. The results showed the changes were more marked in the sympathectomized side and that the severity was directly related to the radiation dose received. It was also observed that the group irradiated every second day developed degenerative changes with low doses, while the other group required a higher dose to show any change; but, on the other hand, the alterations found in the animals irradiated daily were more serious. It appeared that the sympathetic nervous system has some protective action against ionizing radiation. (TCO)

10811 CALCULATION OF THE ALPHA-RAY ABSORBED DOSE TO SOFT TISSUE CAVITIES IN BONE. J. L. Howarth (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Brit. J. Radiol., 38: 51-6(Jan. 1965).

Simple methods are presented for the calculation of the geometrical functions involved in the calculation of the absorbed dose in soft tissue cavities in bone containing α emitters. Tabulated values of these functions are given. (auth)

10812 PRODUCTION OF THYROID TUMORS IN THE RAT TREATED WITH PROPYLTHIOURACIL AND RADIOIODIDE. R. Stoll and R. Maraud (Faculté de Médecine, Bordeaux). Bull. Assoc. Franc Etude Cancer, 50: 389-98 (July-Sept. 1963). (In French)

The production of thyroid tumors, benign and malignant, in some laboratory animals by inhibition of the synthesis of the thyroid hormone by the antithyroid drugs and ^{131}I has been demonstrated. However, use of high doses (400 μC) of ^{131}I is not as successful as the use of lower doses (30 μC). In this study, several groups of Wistar rats were administered a 6% solution of propylthiouracil (PTU) as drinking water with a normal diet, starting when the animals were

three months old. This regimen was given over periods of one, three, or six months, and to one of the groups for longer. The ^{131}I was given by injection at a dose of 30 μC, a dose similar to that used clinically to treat toxic goiter. The control weight of the thyroid averaged 30 mg and there were three adenomas in the 14 animals. In the other groups there was a definite increase of the organ weight to between 42 mg and 135 mg. Besides an increase in thyroid weight in the animals treated with PTU for one month, adenomas developed in 7 out of 16 rats. In the 18 rats treated with PTU and ^{131}I for three months, 10 developed adenomas and three adenocarcinomas. In the third lot of five rats treated for six months with PTU, and the same dose of ^{131}I, three developed adenomas and two adenocarcinomas. In 14 rats treated with ^{131}I only, four developed adenomas. Out of six treated with PTU chronically, four had adenomas, and in the last group of five rats treated for six months with PTU, all developed adenomas. The results show that the combination of PTU and ^{131}I is able to produce thyroid adenomas and adenocarcinoma. Moreover, PTU alone can produce adenomas. As the dose used in the treatment of the toxic goiter with ^{131}I is similar, in terms of dose and body weight to the dose used in rats here, this combination should be avoided in humans and a better choice made in the treatment of thyroid hyperfunction. (BBB)

10813 EFFECT OF IONIZING RADIATION ON THE 24-HOUR RHYTHM OF MITOTIC ACTIVITY IN THE CORNEAL EPITHELIUM OF MICE. V. M. Mastryukova and A. D. Strzhizhovskii. Byul. Eksperim. Biol. i Med., 58: 106-9 (1964).

The effects of local and whole-body irradiation on the 24-hr mitotic activity rhythm of corneal epithelium were investigated in 200 white mice in two experimental series. In the first series corneal epithelium of mice was exposed to local soft x-irradiation of single 200 and 700 R doses calculated to be almost completely absorbed by the corneal epithelium. In the second series mice were x irradiated with whole-body single 200 and 700 R doses. The mitotic index for the corneal epithelium of control animals was found to fluctuate. With a 200 R local radiation dose, mitotic activity fluctuations of the tissue were completely depressed 24 hr after irradiation, partially restored by the 4th day, and completely normal by the 10th day. Mitotic activity fluctuations were similar for a 700 R local radiation dose. For a 200 R whole-body radiation dose the effect was comparable to that of a 200 R local radiation dose, but mitotic activity fluctuation was only partially depressed after 24 hr. With a 700 R whole-body dose mitotic activity fluctuation was even less depressed, but with passing of time the fluctuation amplitude decreases significantly compared to the other mitotic indices. The explanation for the mitotic activity fluctuation is based on the position that there is a relation between mitotic activity of the tissue and the tissue level of determinant metabolites necessary for mitosis. (auth)

10814 FURTHER OBSERVATIONS ON LATE SOMATIC EFFECTS OF RADIOMIMETIC CHEMICALS AND X-RAYS IN MICE. J. W. Conklin, A. C. Upton, and K. W. Christenberry (Oak Ridge National Lab., Tenn.). Cancer Res., 25: 20-8(Jan. 1965). (ORNL-P-133)

Young adult female RF mice were subjected to four successive midlethal doses of nitrogen mustard (HN2), triethylene melamine (TEM), 1,4-dimethanesulfonoxybutane (myleran), or whole-body x rays. The agents were given at 14-day intervals, and the survivors were observed for effects on longevity and on the incidence of late occurring diseases. The percentages of mice dying within 30 days after treatment in the various groups were: TEM, 12.5%; HN2, 10%; myleran, 3%; x rays, 1%; and control, 1%. The life-span of 30-day survivors was shortened in all treated groups, with mean survival times as follows: x rays, 355 days; TEM, 427 days; HN2, 490 days; myleran, 511 days; and controls, 632 days. Although all the agents were highly oncogenic, the decrease in longevity was not attributable solely to neoplasia, but was correlated with premature mortality in various diseases associated with aging. Thymic lymphomas were induced by all agents, but myeloid leukemia only by x rays. The incidence of ovarian tumors was increased by TEM, myleran, and x rays. The incidence of pulmonary adenomas was increased by HN2 and TEM. All agents caused premature development of lens opacities, but only myleran and x rays induced lens changes significantly more severe than those developing spontaneously in senile controls. (auth)

10815 STUDY OF THE CHROMOSOMES IN TWELVE SUBJECTS HAVING RADIODERMITITIS. Claude Mouriquand, Janine Patet, Jean Darnault, Claudine Gilly, Pierre Jalbert, and Charlotte Wolff (Centre d'Etudes Nucléaires, Grenoble, France). Compt. Rend., 259: 3830-3(Nov. 23, 1964). (In French)

The study of the caryotypes of 12 subjects professionally exposed to x radiation and having radiodermatitis revealed the existence of a very high number of structural modifications when compared to controls. (tr-auth)

10816 RADIOBIOLOGICAL EFFECTIVITY, RBE, AND REM. H. R. Schinz and R. Wideroe. Deut. Med. Wochsehr., 89: 1310-14(July 3, 1964). (In German)

The first effect of ionizing radiation is to alter the macromolecules of cells, such as proteins, enzymes, and RNA and DNA. These effects are produced directly, or indirectly, by means of free radicals. The secondary effects of radiation may consist of gene mutations, chromosomal breaks and translocations, disturbances of enzyme, RNA or DNA synthesis and activity, permeability changes, or alterations in other cellular activities. The action of radiation to kill cells in cell cultures appears only after a definite threshold value and follows a sigmoid-shaped curve. One explanation for this could be that sensitivity of the cells to 200-kv x ray, for instance, varies from cell to cell, with some cells extremely sensitive and others relatively insensitive, but with most of the cells showing median sensitivity. Another explanation could be that a cumulative effect is necessary to kill cells. It was concluded that relative biological effectiveness can vary with the type of radiation or the tissue, and is a measure of radiation effectivity, as compared to 200-kv x ray. It is a factor that when multiplied by the physical dose, measured in Rads (100 erg/g) gives the Rad equivalent for man, or Rem. (TCO)

10817 ON ACCELERATION OF HEALING FRACTURES IN IRRADIATED ANIMALS. F. M. Golub and A. I. Britun (Samarkand Pavlovian Medical Inst., USSR). Eksperim. Khirurg. i Anesteziol., 8: 44-5(Mar.-Apr. 1963). (In Russian)

Experiments with 92 rabbits are described, with 20 acting as controls. In the first (control) group, the second metatarsal bone of the right foot was fractured. X-ray and histologic study showed complete normalization of the entire marrow canal within 60 to 75 days; healing first became apparent on the tenth to fifteenth day. In the second group, 40 rabbits sustained a similar fracture one day after receiving a 400-R dose of x rays. Twelve rabbits died shortly after irradiation. In the remaining 28, formation of bone callus was slow, often abnormal. No consolidation of bone fragments developed by the 75th to 90th day, nor even after 120 days. Some animals developed arthritic symptoms. The third group of 32 rabbits sustained fracture preceded by irradiation (400-R) the day before. Immediately following infliction of fracture, a sustained nerve block was induced by injecting Novocaine-alcohol solution into the soft tissue of the right thigh. In addition to major nerves, such as the sciatic, subcutaneous and intramuscular nerves were affected also. Three rabbits died shortly after irradiation and fracture. X-ray and histologic examinations of the other 29 showed normal healing by the 60th to 75th day, and the ultimate results were identical with those in the control group. In an additional experiment on ten rabbits receiving 400 R one day, followed by fracture of the second metatarsal of the right foot the next day and immediate sustained nerve block with Novocaine-alcohol solution injected into soft tissues of the left thigh, the results were identical with those in the nonirradiated controls within the same period of time. It is concluded that, by blocking nerve tracts on the side of the fracture, as well as on the opposite side, it is possible to accelerate regenerative processes in bone

callus formation even in the presence of radiation illness. (BBB)

10818 EFFECT OF IONIZING RADIATION ON THE RATES OF PHOTOSYNTHESIS AND RESPIRATION IN DIFFERENT VARIETIES OF COTTON DIFFERING WITH RESPECT TO RIPENING RATE. N. N. Nazirov (Inst. of Genetics and Plant Physiology, Tashkent). Fiziol. Rast., 11: 328-30(1964). (In Russian)

Radiation effects on photosynthesis and respiration were studied in two varieties of cotton: a radioresistant, late-ripening variety and a radiosensitive variety that ripened earlier. The photosynthetic process was measured by a $C^{14}O_2$ technique, and respiration was detected manometrically. Whereas in control plants photosynthesis rates increased with growth and development, the process was activated in irradiated radioresistant plants and depressed in the irradiated radiosensitive varieties. Respiration in the unirradiated controls decreased with growth and development, but was appreciably activated by irradiation in both radioresistant and radiosensitive varieties. As a result, growth and production of the radiosensitive variety were greatly retarded. (H.M.G.)

10819 RADIATION SURVIVAL OF ERWINIA ATROSEPTICA AND ERWINIA CAROTOVORA TO ^{60}Co GAMMA RAYS. Bohdan M. Slabyj and Alexander M. Dollar (Univ. of Washington, Seattle). Food Irradiation, 5: No. 1-2, A22-4(July-Dec. 1964).

The radiation sensitivity of Erwinia carotovora and E. atroseptica bacteria associated with soft rot in potatoes, was determined, using a ^{60}Co source. A radiation dose of 3 to 5 krads was required for a tenfold reduction in viable cells, when the bacteria were suspended in a phosphate buffer or in Brain Heart Infusion medium. The dose required for the same reduction in numbers of E. carotovora, inoculated into potato tubers, was 9.5 krad. (auth)

10820 A STUDY OF THE EFFECT OF BONES AND BONE MARROW OF DISTANT IRRADIATION WITH ^{60}Co. A STUDY OF THE EFFECT ON BONES. Mitsuto Nakano (Kyushu Univ., Fukuoka, Japan). Fukuoka Igaku Zassi, 51: 529-42(May 1960). (In Japanese)

Macroscopic, roentgenologic, anatomic, physical, and histologic examination was made of rabbits whose right or left hips were irradiated over a field of 10×10 cm^2 with 1200- to 8000-R doses of γ rays from ^{60}Co and, for comparison, of treated rabbits. Macroscopically, irradiation with 5000 R or more caused lack of appetite, diarrhea, weight loss, progressive atrophy of the soft tissues in the irradiated hip, and rigidity of the hip joint. Roentgenologic examination showed that irradiation with 4000 R or more was followed in ~ 150 days by the appearance of such changes in the irradiated hip as to give the impression that the femur is curved and shortened, with its compact bony substance thickened towards the medullary cavity and causing enostosis in it. Anatomically, irradiation with 5000 R or more caused atrophy of the soft tissues of the irradiated femur and rigidity of the hip joint, without producing such morphologic changes as curvature, shortening, or fracture of the bone. As seen in cross-section the bone was either slightly thickened, a trifle thinned, or unaffected, in compact parts according to the dose of γ rays applied: 5000, 8000, or 3000 R. Osteometric results showed that the exposed femur was a little reduced in length, left unchanged in the transverse diameter at the diaphysis, increased in weight, and hardened in its metaphyseal compact substance. The resistance to compression of the shaft of the bone was increased or decreased to the dose of γ rays applied: 3000 or > 4000 R. Histologically, the shaft of the femur presented the picture of osteogenesis and osteosclerosis after exposure to 5000 R, and that of degeneration after exposure to 8000 R; it underwent no changes after exposure to 3000 R or less. (BBB)

10821 A STUDY OF THE EFFECT ON BONES AND BONE MARROW OF DISTANT IRRADIATION WITH ^{60}Co. II. A STUDY OF THE EFFECT ON BONE MARROW. Mitsuto Nakano (Kyushu Univ., Fukuoka). Fukuoka Igaku Zassi, 51: 957-73(Oct. 1960). (In Japanese)

The effect produced in the hematopoietic tissues of the body by irradiation with ^{60}Co for cancer of the uterus was observed by examining and comparing the bone marrow, and peripheral blood cells before and after each treatment. The nucleated cell count in bone marrow was practically the same before and after each session. The erythroblastic cell count was lower after each round than before, this tendency being more conspicuous after the first than after each subsequent treatment. The marrow leukocytic cell count was lower for myeloblasts and for young neutrophils after each round. The mature neutrophil count was greater after the first session and showed no appreciable variation after each subsequent session. The eosinophil count was the same before and after each fraction. The basophil count was the same before and after the first session and tended to decrease after the second and each subsequent session. The marrow monocyte and lymphocyte counts were the same before and after each round. The plasma cell count was a little greater after the first round than before it and much greater each subsequent session. The reticulum cell count was a little greater after the first fraction than before it and nearly the same before and after each subsequent fraction. The mast cell count in bone marrow was the same before and after each treatment. The megakaryocyte count was the same before and after the first and a little smaller after each subsequent period of irradiation. In the peripheral blood, the hemoglobin level content was slightly greater after the first fraction than before and a little smaller after each subsequent exposure. The red cell count was smaller after the first and lower after each subsequent round. The leukocyte count was greater each fraction, particularly after the second. The platelet count was the same before and after the first and a little greater after each subsequent exposure. The reticulocyte count was unchanged. The leukocytic count was negative for young neutrophils after each round. Basophils and monocytes, and to a lesser extent eosinophils, fell after each irradiation. (BBB)

10822 THE EFFECT OF TEMPERATURE DURING IRRADIATION ON INDUCED MUTATION FREQUENCY IN DROSOPHILA MELANOGASTER SPERM. Frank-Jorgen Sollunn and Oistein Stromnaes (Univ. of Oslo). Hereditas, 51: 1-12(1964).

Three-day-old male Drosophila melanogaster were tested for the induction of dominant lethals and recessive sex-linked lethals in three successive daily broods. The control males were exposed to a temperature of 22°C or 0°C for half an hour. The experimental males were exposed to the same temperatures for the same length of time while they were irradiated with 2500 R doses of x rays. There were no significant differences between the effects of treatments for either type of lethals in the control series. In the experimental series there were significantly higher frequencies of both types of lethals in flies irradiated at 0° than at 22°C. For sex-linked lethals at either temperature and for dominant lethals induced at 22°C the first brood had a significantly higher frequency than the second brood. The frequencies of dominant lethals induced at 0°C exhibited no significant difference between the three broods. Presumably the difference in temperature during irradiation is responsible for the observed differences in induced mutation rate. The frequency of dominant lethals increased about 40% when the temperature was lowered from 22° to 0°C during irradiation, and the corresponding increase in recessive sex-linked lethals was about 90%. It is suggested that the temperature effect may act primarily on the breakage process and secondarily on the restitution process, or on both. Chemical reactions, which may be involved in the breakage as well as in the restitution processes, might be influenced by temperature changes, or the lowered temperature may change the viscosity within the nucleus, or it may change the stress in the chromosome coiling. To explain these data several other factors which may influence the mutation rate are proposed. Thus changes in oxygen pressure may be partially responsible for the higher frequencies induced at the lower temperature. However, possible inactivation of radioprotective systems at the lower temperature must also be taken into account. The oxygen effect may obscure the effect of protective systems when a

comparison is made between temperature treatments within broods. However, a comparison of the frequencies between broods within temperature treatments indicates that radiation protective systems may be active in lowering the induced mutation rate from first to second brood. This conclusion is drawn from the data for the dominant lethal series. That the data for the sex-linked lethals do not exhibit exactly the same picture as for dominant lethals is ascribed to the different nature of the two types of lethals. (BBB)

10823 RADIOSENSITIVITY OF DROSOPHILA SPERMATOGONIA. II. PROTRACTED DOSES. Per Oftedal (Norwegian Radium Hospital, Montebello). Hereditas, 51: 13-30(1964).

On the basis of previous results obtained after acute treatments of Drosophila spermatogonia, a mathematical model for the cell population under irradiation was formulated. With this model, which is based on the assumption of variation in cell radiosensitivity with the mitotic cycle, and correlation between the sensitivities to killing and to mutagenesis, it is possible to predict that within a certain dose range, a higher frequency of scoreable mutations should be obtained with protracted doses than with acute. A test of these predictions, measuring the frequency of sex-linked recessive lethals after protracted exposure, is described. Experiments were first made with a ^{137}Cs source giving doses of 144 and 267 R over 8 hr; subsequently, the effects of 300, 400, and 542 R/8 hr were measured. The control mutation rate was 0.31 compared with 0.50, 0.66, 0.75, 0.40 and 0.38 for these respective doses. The frequencies of sex-linked recessive lethals found in the irradiated groups indicated an increase with dose up to about 300 R, and a falling off for the higher doses of 400 and 542 R. The mutation frequencies obtained after protracted doses extended to higher values than those found after earlier acute treatments, but the general shape of the dose effect curve was the same. The value after 144 R/8 hrs was not different from those found after treatment with 25 R/min of x rays. The value after 300 R/8 hr was the highest obtained in studies of spermatogonial radiosensitivity. Comparison of the data with those previously obtained after acute treatments showed that the dose-rate effect expected on the basis of the model proposed was obtained. By protraction of doses over the relatively short period of 8 hr, cell killing was apparently reduced to an extent that led to higher yields of observable mutations. The value for the mutagenic sensitivity e_{obs} for spermatogonia derived from the results was about $1.5 \cdot 10^{-5}$ sex-linked recessive lethals/R. (TCO)

10824 GENETIC STUDY OF THE BEAN PLANT AFTER EXPOSURE TO X RADIATION AND TO A COBALT-60 SOURCE. S. T. Wang (Chung Hsein Univ., Taiwan, China). Ho Tsu K'o Hsueh, 4: 149-64(Feb. 1964). (In Chinese)

Genetic experiments were carried for two years on three generations of beans exposed to total doses of 10,000 R and 15,000 R of x radiation and gamma radiation from a ^{60}Co source. The effect of the radiation on budding, appearance of the leaves, survival rate, growth rate, overall height, coloration, the amount of seeds produced, immunity from disease and unit seed weight was determined. The results revealed that the problem of reducing the deleterious effects of radiation and of enhancing the creation of beneficial mutation is very complicated. The factors, such as the type of radiation, the dose rate, the period of exposure, the water content of the plant, etc. are closely related to the ultimate effect. It is concluded that the three generations examined are not sufficient to solve these questions; at least four generations seem to be required. (TTT)

10825 GENETICAL STUDIES ON HEADING IN RICE PLANTS. II. GENE-ANALYSIS ON HEADING OF SOME EARLY HEADING MUTANTS INDUCED BY X-RAY. T. Matsuo (Tokyo Univ.), T. Nakajima, and A. Hirata. Ikushugaku Zasshi, 10: 174-8(1960). (In Japanese)

A gene analysis was made in five x-radioinduced mutants for early heading in rice. The earliness was attributed to the recession of one gene related to heading time. Genes related to the earliness of each strain were found to be independent. Therefore, it was suggested that four major genes exist for early heading, especially photoperiodic sensitivity. In one strain the gene for photoperiodic sensitivity was shown to be related to minimum heading duration. Some morphological and physiological traits were also attributed to the recessive mutation of one gene, independent of genes related to heading time. (H.M.G.)

10826 STUDIES ON THE PROCEDURE OF MUTATION BREEDING WITH SIX-ROWED BARLEY. I. THE METHODS OF PROCEDURE IN X_1 AND X_2 GENERATIONS. Genkichi Takeda and Masujiro Kan. Ikushugaku Zasshi, 13: 211-16(1963). (In Japanese)

Dormant barley seeds were treated with 15 kR of x rays and methods of mutation breeding were applied on six rowed barley in three ways: method A–after 3 ears were harvested from each X_1 plant and one grain was removed from each ear, these grains were planted in bulk at X_2; method B–after one ear was harvested from each X_1 plant, the grains were planted separately as ear progenies at X_2; and method C–after 3 ears were harvested from each X_1 plant, the grains were planted separately as plant progenies at X_2. Method A was compared with B and C. The characters mainly analyzed were early yield and stem-shortness. The selection of such aberrants was carried out in X_2, and these were confirmed as mutants in X_3. In the case of method A-II, selection was made by measuring stem length at X_2 generation. In the case of other methods, selection was made by observation. By using method A, the mutant types found in X_2 were more frequently observed compared with the other two methods and the mutant much deviated from the parent type were involved. This result was compatible with the theoretical consideration of Yoshida (1962). Much better selection of short stem mutants was made in X_2 by method A (I + II) than by methods B and C. This result demonstrates that the individual selection using this measurement was made much better than the pedigree selection through observation. (auth)

10827 TELANGIECTASIS AS A SIGN OF REPAIR IN THE X-RAY DAMAGED SKIN. A. Wiskemann (Universität, Hamburg). Israel J. Exptl. Med., 11: 148(Feb. 1964).

Experiments on the blood flow in x-ray induced atrophic skin were made by measuring the specific thermal conductivity of the skin with and without suppressing the blood supply. In contrast to the tissue clearance technique, this method does not take into account changes in the permeability of the vessels. Three patients who had received an overdose of x rays 10 to 20 yr earlier were examined. After heating the skin with infrared light, in all cases a more intensive blood flow (as seen by heat convection) was observed below the surface of the radiation-damaged skin than in the contralateral normal skin. This positive result is partially due to the method used, which is more sensitive for the blood flow in the superficial telangiectatic vessels than in the vessels of the deeper corium. Nevertheless, the measurements make it clear that the development of telangiectasis is functionally expressed as an intensified blood flow just below the epidermis. This is regarded as a sign of a repair process occurring in the irradiated tissue. (TCO)

10828 RADIATION-INDUCED DAMAGE TO PLANT TISSUES AS A CAUSE OF THE INTENSIFIED ATTACKS BY MICROORGANISMS FOLLOWING IRRADIATION. J. P. Skou (Atomenergikommissionen, Riso, Denmark). IVA (Ingeniersvetenskapsakad.) Medd., No. 138, 72-8(Sept. 1964).

Following irradiation, plant products frequently show increased rot as compared to untreated samples, the attack increasing with increasing doses of radiation. These phenomena may be caused by injury to the tissues, facilitating the access of microorganisms, effects on specific properties of relatively resistant microorganisms, and combination of these two factors. Attempts were made to determine whether γ irradiation causes an increase in permeability and, consequently, exudation from the cells to a degree sufficient to be of importance for the growth of the saprophytes. The results of the permeability studies on carrot

tissues are described. At 500 krad the hydration curve was significantly lower, at 750 krad there was virtually neither increase nor loss of weight, whereas the samples at 1000 and 1450 krad showed considerable weight losses. Release of sugar from carrot discs to water tended to increase exponentially with the dose. The dry matter analyses were in agreement with this result. Hence the cause of the course of the hydration curves is an exponentially increasing exudation of dry matter (sugar and salts) from the tissues with increasing doses. The untreated material showed the greatest weight loss. With increasing doses the weight loss decreased. At 1450 krad there was constant weight increase. Parallel microscopic studies showed strong plasmolysis of all cells in untreated material and at low doses, but no plasmolysis took place from about 750 krad upwards. There was a considerable increase in weight immediately following the transfer to water. It was concluded that the methods used showed an exponential increase in the permeability of the tissues with increasing doses. Hence, the exudation and the easier access to the cell contents provide one important reason why the saprophytes gain importance with increasing doses. (BBB)

10829 MORPHOLOGICAL CHANGES IN PINE INDUCED BY TREATMENT OF THE SEED WITH GAMMA RAYS AND COLCHICINE. G. F. Privalov (Novskibirsk State Univ., Siberia). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 8, Ser., Biol.-Med. Nauk, No. 2, 98-102(1964). (In Russian)

Studies of morphological changes in Pinus silvestris L. seeds treated with colchicine and 1, 5, or 15 kR γ-ray doses showed that: 1 kR stimulated germination; 5 kR did not affect germination; and 15 kR proved lethal. The survival of the first vegetative stage of seeds irradiated with 1 kR was 22%; with 5 kR, 19%; and without irradiation, 53%. Treatment with γ rays and colchicine did not greatly affect the growth and development of plants. However, certain morphological changes were expressed, such as the wider needles and a larger number of needles in plants from irradiated seed. (R.V.J.)

10830 EFFECTS OF GAMMA RADIATION ON THE FERTILITY OF THE TWO-SPOTTED SPIDER MITE AND ITS PROGENY. T. J. Henneberry (Dept. of Agriculture, Riverside, Calif.). J. Econ. Entomol., 57: 672-3(Oct. 1964).

Spider mites (Tetranychus telarius were exposed to γ radiation from a ^{60}Co source which delivered ~ 280 R/min. Males and females were exposed to doses of 1, 2, 4, 8, 16, or 32 kr. Males (1-day-old) were irradiated in the adult stage, females in the quiescent deutonymph stage. Mites were held at a temperature of ~ 75°F before, during, and after irradiation. Each treated male was confined with an untreated quiescent female deutonymph, and treated female deutonymphs were confined with an untreated adult male. Females thus mated to irradiated males produced fewer female progeny and more nonviable eggs as the dosage of radiation increased. At a dose of 32 kr there were male progeny and nonviable eggs but no female progeny. Virgin females exposed to γ radiation and mated to untreated males produced fewer males and females as the dosage increased from 1 to 24 kr, and after exposure to 32 kr produced only nonviable eggs. Surviving female progeny of males irradiated at 8 kr or more were incapable of reproduction, and female progeny of males irradiated at 2 or 4 kr produced fewer males and females and more nonviable eggs than female progeny of untreated parents. Evidence for sperm inactivation or death was observed at doses of 96 kr and above. These results demonstrate the radiation-induced dominant lethal effect in T. telarius. Thus, untreated females mated to irradiated males produced about the same number of haploid males as did untreated pairs. With an increasing radiation dose the number of females produced decreased and the number of nonviable eggs produced increased. Death in the egg or developmental stages of females was due to the lethal effect in the male gamete since unfertilized eggs produced only males. Similar results have been reported with Habrobracon spp. In addition to lethal effects resulting in death of the progeny of untreated females mated to irradiated males, the surviving F_1 female progeny were incapable of reproduction. This effect was produced by a radiation dose far below that required to induce dominant lethality in 100% of the sperm of parent males. Thus, the introduction of irradiated males into untreated populations need not result in death of the progeny to effect a decrease in the subsequent population size. (BBB)

10831 SPERMATOGENESIS OF THE SILKWORM AND ITS BEARING ON RADIATION INDUCED STERILITY. PART II. Toshihiko Sado. J. Fac. Agr. Kyushu Univ., 12: 387-404(Aug. 30, 1963).

Normal spermatogenesis of the silkworm is described with special reference to the correlation between the developmental stages of the larvae and the germ cell stages and to the duration of the successive stages of spermatogenesis. Radiation responses of spermatogenic cells were investigated by means of fertility tests and histological and cytological observations on the irradiated testes (or germ cells). The experiment was designed to investigate the reasons for the seeming contradiction between the findings on mice and adult Drosophila on the one hand, and those of the silkworm on the other as to the cytological causes of radioinduced sterility. An attempt was made to establish the latest larval stage at which irradiation yields spermatozoa treated exclusively as spermatogonia. (H.M.G.)

10832 A HISTOCHEMICAL ANALYSIS OF THE EFFECT OF IRRADIATION ON MURINE DUODENAL MUCOSA. H. M. Spiro (Yale Univ., New Haven) and A. G. E. Pearse. J. Pathol. Bacteriol., 88: 55-60(July 1964).

A study was made of the morphologic and associated histochemical events in the duodenum and jejunum of mice after 900-Rad whole-body x irradiation. Within 12 hr of irradiation, mitoses were reduced in the crypt cells. Later the crypt cells failed to mature, enlarged, and appeared abnormal, and lost their motility. This leads to the disappearance of the epithelial cover and collapse of the villi; within a few days, normal crypt cells reappeared and the villi were reconstituted. The resistance of the intracellular enzymes to direct damage by irradiation was evident. One-half hr after irradiation, there appeared to be an increase of esterase and cathepsin activity in otherwise normal-looking villous epithelial cells. Within 24 to 48 hr, this increased activity was quite marked. Secondly, 72 hr after irradiation the epithelial cells lost most of their enzyme content, except for succinate dehydrogenase, and were shed, leaving villi denuded of their protective mucus barrier and deprived of enzymic activity. The histochemical integrity of the villi was quickly repaired and the villi were almost completely normal 96 hr after irradiation. The mechanism of the increase in enzymic activity after irradiation is uncertain, but may have been a direct effect of irradiation or an indirect result of stimulation of the pituitary. This apparent increase in activity of the intracellular enzymes did not kill the cells, nor did it interfere immediately with their vitality. Acid phosphatase, which is regarded as a lysosomal enzyme, and whose activity might be expected to increase if radiation disrupted the lysosomes, showed no increase in histochemical activity until 48 hr after irradiation. There was no histochemical evidence of any extracellular leakage of enzymes, suggesting that the increase in enzymic activity found in tissue homogenates after irradiation was of intracellular origin only. The study also provided histochemical evidence that the decrease in enzymic activity occurring at 72 hr is specially localized to the villi. These results provided a functional morphologic basis for the decrease in absorption noted three to four days after irradiation. At this time not only are the villi stunted and atrophic, but the cells that cover them are depleted in enzyme content. This lack of enzyme presumably is a factor in the failure of intestinal transport. (BBB)

10833 INVESTIGATION OF THE EFFECTS OF FAST NEUTRON IRRADIATION AND Co-60 GAMMA-IRRADIATION ON SPERM COMPOSITION IN RAT TESTES. A. K. Mirakhmedov. Med. Zh. Uzbekistana, No. 2, 45-8(1964).

The effects of gamma and fast neutron irradiation on sperm and testis were compared in two groups of white rats

(150 to 220 g). The first group of animals was gamma irradiated (^{60}Co unit, 26 to 33 R/sec) with a single 400 R dose, and the second group was irradiated with fast neutrons (VVP-s reactor, 2000 kwt) for 1 hr. Animals were killed, 1, 3, 4, 7, 14, 30, 60, and 90 days after irradiation. Radiation damage was determined by changes in testis weight and in sperm. After testes were weighed, sections were prepared to find the number of sperm cells in all developmental stages. An analysis of the findings showed that the weight of the testis started to decrease on the first day after both types of irradiation and continued to decrease reaching its lowest weight on the 60th day. The number of spermatogonia was found to decrease more markedly than other cellular elements for both types of irradiation. The lowest number of prespermatocytes was found on the 30th day and the highest number on the 60th day for both types of irradiation. With fast neutron irradiation the number of spermatocytes decreased significantly on the first day, and with gamma irradiation it decreased on the 14th day. Spermatids disappeared on the 30th day after fast neutron irradiation and on the 60th day after gamma irradiation. Generally fast neutron irradiation was more effective than gamma irradiation. The highest loss of sperm cells and lowest testis weight were found on the 60th day. The immature spermatogonia were most sensitive to irradiation. Spermatogenesis was partially restored by the 90th day. (OTS)

10834 BIOLOGICAL EFFECT OF ULTRAVIOLET RADIATION ON ACTINOPHAGES. N. M. Mkrtumyan and S. I. Alikhanyan. Mikrobiologiya, 33: 73-8(1964).

The effects of ultraviolet radiation on actinophages were studied after two experiments were staged to determine: actinophage type I growth, and morphology of negative colonies formed by extracellular actinophages and infected sprouts in B-6 cultures. Actinophage type I was found to sprout in Act. Streptomycini B-6 population approximately 75 min after infection and to continue growing for 45 min. When actinophages and 12 hr sprouts of actinomycete treated with embichine were sown, large homogeneous negative colonies formed in all the B-6 cultures, but such colonies were found in only 44% of the control group cultures. In a series of experiments with ultraviolet radiation the following were determined: sensitivity of free and intracellular actinophages to ultraviolet radiation; inhibiting effect on reproduction; and effect of irradiated host cells on actinophage sensitivity to ultraviolet radiation. The intracellular actinophage was found to be 40 times more resistant to ultraviolet radiation than the free actinophage and 10 times more resistant than the noninfected sprout. An ultraviolet irradiated actinophage started to sprout 30 min later than in the control group. Survivability of nonirradiated actinophages did not change when sown on irradiated host cells. However, irradiated actinophages sown on irradiated host cells produced 4.7 times fewer negative colonies than when sown on nonirradiated host cells. Consequently, irradiated actinophages should be sown on nonirradiated host cells to increase their survivability. It is hypothesized that the genetic material of the actinophage and the host cell are homologous and that damaged actinophage genetic material is possibly replaced by the host cell. (OTS)

10835 EFFECT OF IONIZING RADIATION (PLESIOTHERAPY) ON THE GLYCOGEN AND MUCOPOLYSACCHARIDE CONTENT OF THE SKIN IN THE GUINEA PIG. L. Bruni (Universita, Pavia, Italy). Minerva Dermatol., 38: 53-8(Feb. 1963). (In Italian)

Change in glycogen and acid and neutral mucopolysaccharides of the skin of guinea pigs was investigated in relation to the effects of 60-kv x rays given in doses of 500, 1000, 2000, and 3000 R. Glycogen tended to increase at first and then to disappear, proportionally to the dose and time of observation (6, 24, 48, and 96 hr and 15 to 30 days after irradiation). Metachromasia (representing acid mucopolysaccharides) increased at an early stage (first 6 to 96 hr) and then decreased gradually to normal values within 30 days, although an intense reaction was sometimes still apparent even 15 days after irradiation. A similar behavior was observed with the use of Alcian blue. Periodic acid-Schiff (PAS) positivity tended to decrease at first followed by a late recovery. The PAS-reactive substance, present after diastase digestion, presumably reflects neutral mucopolysaccharides. It is concluded that radiation alters the physico-chemical state of these tissue polysaccharides, presumably causing their depolymerization into smaller fragments. It is suggested that this may be a direct manifestation of the ionizing radiation, or it may be caused indirectly by a radioinduced activation of tissue depolymerizing enzymes. (BBB)

10836 THE SELECTION OF MUTANTS OF ESCHERICHIA COLI WITH IMPAIRED CELL DIVISION AT ELEVATED TEMPERATURE. P. Van de Putte, Jeannette Van Dillewijn, and A. Roersch (TNO, Rijswijk, Netherlands). Mutation Res., 1: 121-8(July 1964).

After treatment of a strain of Escherichia coli K 12 with the mutagenic agent N-methyl-N'-nitro-N-nitrosoguanidine, mutants were selected which divide normally at 30° but which show a strong inhibition of cell division during growth at 42°. According to their phenotype at elevated temperature the mutants were divided into the following classes: mutants that showed a complete inhibition of cell division and had no colony forming ability at 42°; mutants that showed an incomplete inhibition of cell division and formed colonies at 42° that consisted essentially of long filaments; and mutants with no colony forming ability at 42° and in which the inhibition of cell division was accompanied and probably caused by an inhibition of nucleic acid synthesis. Mutants falling into the first class and not subject to inhibition of nucleic acid synthesis were studied in more detail. The temperature-induced inhibition of cell division, unlike the inhibition of cell division induced by ultraviolet irradiation, was not reversed by treatment with the agent pantoyllactone. Both inherited properties, sensitivity of temperature-induced and radiation-induced inhibition of cell division, are chromosomally determined; the corresponding genes however are located at different sites on the bacterial chromosome. (auth)

10837 THE DOSE-DEPENDENCE OF X-CHROMOSOME LOSS AND NON-DISJUNCTION INDUCED BY X-RAYS IN OOCYTES OF DROSOPHILA MELANOGASTER. H. Traut (Kernforschungszentrum, Karlsruhe, Ger.). Mutation Res., 1: 157-62(July 1964).

The dose-dependence of X-chromosome loss and non-disjunction induced by x ray was investigated in oocytes of Drosophila melanogaster. The frequency of X-chromosome loss increases faster than linearly with dose, suggesting that this effect is based on both one and two hit events. Whereas the induction of single non-restituting chromosome breaks seems to be a plausible explanation for at least part of the one hit events, the two hit component, though statistically highly significant, is more difficult to interpret. One possibility, the induction of large deletions in the maternal X which would require two breaks and simulate the loss of the whole X-chromosome, was ruled out by special experiments. The dose-effect relationship for non-disjunction seems too complicated to permit a simple hit explanation. Perhaps radiation-induced stickiness of the chromosome surface, an effect probably not caused by individual hits, prevents the X-chromosomes from separating at meiosis. Both the X loss and non-disjunction frequency show a stepwise increase with x-ray dose. Tentative explanations for this effect are given. (auth)

10838 CHROMOSOME ABNORMALITY AND RADIATION SENSITIVITY IN STORED ASCITES-TUMOUR CELLS. Christine Hawes, Alma Howard, and L. H. Gray (Mount Vernon Hospital, Northwood, Middx., Eng.). Mutation Res., 1: 193-201(July 1964).

When ascites-tumor cells were stored outside the body under anoxic conditions at 37° for 2 hrs or more, and then reinoculated and examined after 15 hrs growth in new host mice, they showed higher rates of chromosome aberration and cell death than unstored cells. The rates were higher still if the cells were shaken during storage. Conditions which greatly increased the frequency of chromosome fragments did not appear to increase the number of bridges, suggesting that chromosome-rejoining mechanisms may

have been affected. The damage is not apparently mediated through any factor accumulating in the medium in which the cells are suspended during storage. Little or no increase in spontaneous chromosome aberration rate was seen in cells stored for 14 to 16 hrs in air or N_2 at 3° without agitation, or for 12 hrs in air at 37° with very gentle shaking. When cells were stored under conditions which did not by themselves increase the rate of aberration, their sensitivity to x rays was increased. Storage for 10 hrs or more before irradiation, either in air at 3° or 37° or anoxically at 3°, had the effect of a 50% increase in dose. Storage after irradiation had little or no effect on abnormality rate. Attempts to prevent the increase in sensitivity to radiation by the addition of glucose or ATP were unsuccessful. (auth)

10839 MUTATION IN CONTINUOUS CULTURES. PART II. MUTATIONS INDUCED WITH ULTRAVIOLET LIGHT AND 2-AMINOPURINE. H. E. Kubitschek and H. E. Bendigkeit (Argonne National Lab., Ill.). Mutation Res., 1: 209-18(Oct. 1964).

Rates of induction of mutation to resistance to bacteriophage T5 were determined as a function of generation rate in cultures of strains of Escherichia coli B for two mutagens, ultraviolet light and 2-aminopurine. With ultraviolet light, induction was independent of generation rate. With 2-aminopurine induction was directly proportional to generation rate. The dependence of induction upon generation rate was the same for tryptophan and glucose-limited cultures. In these experiments selection of mutants, both newly forming and expressed, was absent or negligible, ruling out the possibility that these rates of induction were modified by selection. The results also imply that changes in growth rate did not affect the concentration of effective mutagen or otherwise alter the rate of induction by secondary reactions. Furthermore, the results support the interpretation that any single process of mutation can give rise to only one of two basically different responses. Induction can only be directly proportional to, or independent of, generation rate, because mutation occurs during the synthesis of the gene or after synthesis is completed. (auth)

10840 X-RAY INDUCED MUTABILITY IN MALE GERM CELLS OF DROSOPHILA MELANOGASTER. G. Lefevre, Jr. and Ulla-Britt Jonsson (Harvard Univ., Cambridge, Mass.). Mutation Res., 1: 231-46(Oct. 1964).

From the time the Drosophila melanogaster male is less than an hour old, sperm are continuously maturing, becoming motile, and entering the seminal vesicle, regardless of sexual activity. When a male at any stage in its life history, is exposed to x rays, all existing germ-cell stages are simultaneously irradiated. After irradiation, sperm will be sequentially produced by the male more or less in order of their stage of maturation at the time of irradiation, the first sperm samples being comprised of germ cells that were most mature at the time of irradiation. As the time interval between irradiation and the initial mating increases, the sperm samples consist of ever less homogeneous mixtures of cells that were at varying stages of maturity at the time of irradiation. If the male mates at a regulated pace after irradiation, sperm samples can be obtained that enable one to measure separately, and with reasonable accuracy, the mutability of mature sperm, intermediate and late spermatid stages, and early spermatids. Even so, unless each male in an experiment mates the same number of times each day, sampling of the various stages will become more and more asynchronous, as some males will produce sperm derived from stages quite different from those sampled at the same time from other males in the same experimental group. Then, if mutation frequencies are collected in terms of days after irradiation, they will not accurately reflect the mutability of any particular germ cell stage. When appropriate experimental procedures are followed, the mutability of mature, motile sperm is found to be as high, or higher, in male irradiations as in irradiations of inseminated females. The sex-linked recessive lethal mutation frequency characteristic of mature, motile sperm approaches 4% per 1000 R. Immotile sperm stages such as intermediate and late spermatids have a much lower mutability, less than 2% per 1000 R. Early spermatids again have a high mutability, probably exceeding that of motile sperm. The actual mutation frequency encountered at any time following irradiation reflects the proportion of the various kinds of irradiated germ cells in the sperm sample assayed. The precise proportion in any given sperm sample will be related to the age of the male at the time of irradiation, his previous mating history, the length of time that has elapsed between the irradiation and mating, and the number of inseminations that have ensued since the irradiation. The inherent mutability of male germ cells can be correlated with their physiological state at the time of irradiation. Thus, rapidly differentiating early spermatids are highly mutable and radiosensitive. Later, after the major structural modifications of the cell have been accomplished, the immotile intermediate and late spermatids exhibit a low mutability. Finally, in the terminal step in their differentiation the spermatids acquire motility, thereby becoming transformed into functional spermatozoa whose mutability is simultaneously reset to a high level. (auth)

10841 RADIOSENSITIVITY OF THE STAGES OF SPERMATOGENESIS TO DIFFERENT MUTATIONS IN DROSOPHILA MELANOGASTER. O. G. Fahmy and Myrtle J. Fahmy (Royal Cancer Hospital, London). Mutation Res., 1: 247-67(Oct. 1964).

The induction of sex-linked recessive lethals, XO males, and chromosome deletions were followed relative to non-disjunction (XXY females) and induced crossing-over in daily sperm samples from 1X irradiated male Drosophila melanogaster. Non-disjunction marked the sampling of meiotic spermatocytes, prior to and during anaphase I, and its yield was highest on the 10th to 12th days, although a low rate occasionally occurred as early as the 8th, or as late as the 13th day. Accordingly, post-meiotic stages were mainly used during the first 9 days, and meiotic and pre-meiotic stages were sampled starting from the 10th day. Induced crossing-over marked the utilization of diploid germ cells and was substantially sampled on the 10th and later days. Small clusters of recombinants involving the same chromosome site occurred 12 to 13 days after treatment, possibly indicating the sampling of spermatogonia late in the mitotic cycle. The induction of sex-linked recessive lethals and XO males was high in the spermatid stages and decreased sharply in frequency with the increase in the rate of non-disjunction. The response for these mutations, therefore, was considerably lower in meiotic spermatocytes than in early spermatids. The mutation rate for the deletions (y^+ and B from the Y-chromosome) reached its peak before that of non-disjunction but remained high during the sampling of the latter aberrations. Radiosensitivity to the induction of deletions, therefore, although highest in the early spermatids, did extend to the late meiotic spermatocytes. (auth)

10842 TEMPORAL DISTRIBUTION OF X-RAY INDUCED RECESSIVE LETHALS AND RECOMBINANTS IN THE POST-STERILE BROODS OF DROSOPHILA MELANOGASTER MALES. Jaakko Puro (Univ. of Turku, Finland). Mutation Res., 1: 268-78(Oct. 1964).

The distributions of 3rd chromosome recessive lethals and cross-overs were studied in daily post-sterile broods of Drosophila melanogaster males treated as adults with 3000 R x rays and mated singly and sequentially up to the 24th day or until the male became permanently sterile. Following the period of excessive sterility on the 6th to 9th days, with a clear-cut sterile period on the 8th day, a marked increase in fecundity was found on the 10th day. The highest incidence of cross-overs was on the 10th day followed by a progressive decline in the later broods. The decrease in the frequency of lethals was not so evident, possibly because too few flies were tested in the latest broods. Despite the fact that clusters were to be expected, only singles were recovered from the 9th to 10th day broods. Clusters were first found on the 11th day, but frequently not before the 12th day. Many clusters continued for several subsequent broods. It was concluded from continuing clusters that predefinitive gonia, through

repeated camibial-like divisions, preserve the continuous supply of sperm. Thus continuing clusters can be used as a genetic criterion for differentiating between the definitive and predefinitive gonia. With the brood procedure used, treated definitive gonia were sampled on the 9th to 11th days, and predefinitive gonia beginning from the 12th day. Hence the temporal pattern after the 12th day reflects the functional activity pattern of the stem cells. (auth)

10843 THE RELATIONSHIP BETWEEN RADIATION DOSE AND MUTATION FREQUENCY IN SPERMATOGONIA OF DROSOPHILA MELANOGASTER. T. W. McSheehy (Medical Research Council, Harwell, Berks, Eng.). Mutation Res., 1: 296-301(Oct. 1964).

Data are presented on the rate of induction of IInd chromosome recessive lethal mutations in Drosophila melanogaster following irradiation of spermatogonia with ^{60}Co γ rays over a dose range 200 to 800 Rad. The dose-response was linear, the line of best fit being $y = 0.455 + 1.33 \times 10^{-3}$ x. The data are discussed in relation to recently reported work on sex-linked recessive lethals. It was concluded that the linear dose-response reported in this paper resembled that observed at high radiation doses. Furthermore, these data were not incompatible with the non-linear response reported at low radiation doses. (auth)

10844 A METHOD FOR QUANTITATIVE DETERMINATION OF THE RATES OF BACTERIAL AUXOTROPH MUTATIONS. Hanna Dar-Guttman, Y. S. Halpern, and R. Falk (Hebrew Univ.-Hadassah and Hebrew Univ., Jerusalem). Mutation Res., 1: 334-6(Oct. 1964).

A method is described for the quantitative determination of mutation rates of bacterial auxotroph mutations. The method gave good results in a study on the effects of ultraviolet radiation on mutation rates in genes determining amino acid requirements in cultures of Salmonella typhimurium. (C.H.)

10845 A FOLLOW-UP STUDY OF CATARACTS AMONG THE HIROSHIMA AND NAGASAKI ATOMIC BOMB CASUALTIES. Yoshiya Masuda (Kurume Univ., Japan). Nagasaki Igakkai Zasshi, 38: Suppl., 7-12(Dec. 1963). (In Japanese)

A follow-up study of seven atomic-bomb-related cataract cases at Hiroshima Red Cross Hospital is reported. This supplements the study of 21 cataract cases previously made in August 1962 at the same hospital. The cases were classified into four groups as follows: four cases in the first group showing no alteration of cataract condition since the initial examination, none in the second group showing alteration, one case in the third group showing improvement, and two cases in the fourth group showing deterioration of lens transparency. For each case, patient's sex, age, distance from the hypocenter, in or outdoor exposure, status, physical injuries and symptoms of radiation illness, eyesight changes, time lapse between first and second examination, and condition of the cataract are described in detail. When these seven cases are combined with the 21 previous cases, there were a total of eight cases falling into the first group, eight cases in the second, five cases in the third, and seven cases in the fourth. Interpretation of the clinical findings in these cases is discussed. (BBB)

10846 STATISTICAL OBSERVATIONS ON THE RESULTS OF THE EXAMINATIONS OF ATOMIC-BOMB CASUALTIES. PART I. Motoi Miura (Atomic-Bomb Casualties Health Administration, Hiroshima). Nagasaki Igakkai Zasshi, 38: Suppl., 21-6(Dec. 1963). (In Japanese)

From April, 1961, through March, 1962, a large-scale physical examination survey of 34,678 atomic-bomb casualties was made by the City of Hiroshima and its municipal physicians' association. This report outlines the statistical analysis of the tabulation of the results of this examination, giving the general condition of casualties as seen more than ten years after the exposure. The analysis shows the age and sex of the subjects, comparing the results of various blood cell counts, serum precipitation tests, urine tests, and more extensive examinations for special cases. It was observed that, despite the lapse of time of more than ten years, there were no significant differences in the results of these tests for the control and the atomic-bomb casualty groups. However, the fact that complaints of some disorders were more numerous among the casualty group than among the control group, and that two cases of leukemia were found among those who had previously had no symptoms, seems to suggest the existence of latent abnormalities among those who are apparently fully recovered and clinically normal. (BBB)

10847 THE EFFECT OF X RAY ON A TISSUE CULTURE OF EPITHELIAL CELLS IN THE RABBIT EYE LENS. Tsugihiko Tokunaga (Nagasaki Univ., Japan). Nagasaki Igakkai Zasshi, 38: Suppl., 18-20(Dec. 1963). (In Japanese)

An experimental study was made in an attempt to show that the degeneration of the lens epithelial cells is a direct and primary phenomenon independent of either ciliary body or aqueous humor changes. In addition to in vivo studies in rabbits, a culture of rabbit lens epithelial cells was x irradiated (2000 R, 250 kvp, 30 ma, 165 r/min). Light and electron microscopic examinations were made, starting four days after the irradiation for the light-microscopic and one week after the irradiation for the electron-microscopic examination. It was observed light optically that the lens epithelial cells underwent vacuolar degeneration and the formation of auxiliary nuclei two weeks after the irradiation in vivo. In vitro, however, similar cytopathologic changes were noted but much sooner and more intense in development; this was observed only four days after irradiation. Electron microscopic examination revealed in the experimental cultures the presence of abnormal structures in the nuclei, with fragmentation and condensation of their constituents, this occurring sooner in vitro than in vivo. It is considered that the radiation-induced alteration in lens epithelia is a primary occurrence, independent of ciliary body or anterior chamber aqueous humor pathology. (TCO)

10848 HEMOPOIESIS AND NUCLEIC ACID METABOLISM. REPORT II. INCORPORATION OF RADIOPHOSPHORUS INTO NUCLEIC ACIDS IN HEMATOPOIETIC TISSUES OF GUINEA-PIGS WITH ^{60}Co γ-RAYS. Shigeru Shirakawa (Kyoto Univ.). Naika Hokan, 10: 23-35(Jan. 1963).

Experiments were carried out in guinea pigs to elucidate the effect of ^{60}Co γ irradiation at a high dose rate (3.6 kr/min) on hematopoiesis as measured by radiophosphorus incorporation into nucleic acids of hematopoietic tissues, that is, bone marrow, spleen, lymph node, and liver. Three hr after irradiation, decreased incorporation of ^{32}P into DNA of the bone marrow, lymph node, and spleen was noted which appeared to parallel the dose level. With respect to the long-term effect of irradiation at the lethal level (240 r) the incorporation of ^{32}P into both DNA and RNA of the bone marrow was markedly decreased as early as three hr after irradiation. One week after irradiation the incorporation of ^{32}P into DNA was still markedly decreased, while that into RNA was restored nearly to normal. Two weeks after irradiation that into both RNA and DNA was completely restored to normal, and three weeks after irradiation that into DNA was markedly increased as compared with normals. Since drastic changes in cell population are known to occur shortly after irradiation in the spleen, lymph node, and bone marrow, the inhibition of incorporation of ^{32}P into DNA and RNA, as in these experiments, may not be due to interference with the ability of the cells to synthesize DNA and RNA, but may be due to loss of the cells, especially younger cells, that would be actively synthesizing DNA and RNA. Since blast cells appear to be the population with the highest ability to synthesize DNA (and RNA), the overall capacity to synthesize DNA (and RNA) in the bone marrow as measured by the incorporation of ^{32}P into DNA (and RNA) may be interpreted as a reflection of population change of these blast cells. In the 120-r-irradiated group the incorporation of ^{32}P into RNA was restored nearly to normal one week after irradiation, and by two weeks after irradiation that into both RNA and DNA showed a complete recovery to normal. These results may be interpreted as a reflection of the population shift, especially of blast cells, in the bone marrow and appear to be in accord with observations on

cytologic changes in the organs induced by irradiation. (BBB)

10849 ADENOSINE-TRIPHOSPHATASE AND POTASSIUM RETENTION IN X-IRRADIATED ERYTHROCYTES. D. K. Myers and L. Levy (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nature, 204: 1324-6(Dec. 26, 1964).

Studies were made on adenosine triphosphatase and potassium retention in x irradiated erythrocytes in rats to determine whether ATP-ase inhibition could account for the loss of potassium ion from the exposed erythrocytes. No evidence could be obtained for the immediate inhibition of active ion transport or of the associated ATP-ase by moderate doses of x irradiation. Exposure of the liver slices to 60 kR x rays at 0°C did not effect the normal re-accumulation of potassium during subsequent incubation at 37°C. Direct measurements of ouabain-sensitive ATP-ase activity of erythrocytes also showed very little change following x-ray doses from 1 kR up to 60 kR, either with intact rat cells, with rat erythrocyte hemolystates, or with ghost preparations from rat and human erythrocytes. (The total ATP-ase activity also remained constant in these experiments.) Despite the absence of any appreciable effect on ouabain-sensitive ATP-ase, x irradiation did increase the loss of potassium from erythrocytes during prolonged incubation. It was concluded that x irradiation apparently destroys some component of the erythrocytes that they can repair or replace during incubation at 37°C but not at 4°C. (P.C.H.)

10850 CHROMOSOMES OF X-RAY-INDUCED GIANT CELLS IN CHINESE HAMSTER IN VITRO. C. K. Yu (Argonne National Lab., Ill.). Nature, 204: 1334-5(Dec. 26, 1964).

Radiation effects on chromosome in giant cells induced in Chinese hamster in vitro were investigated. The cells were x irradiated at a dose of 1500 R with 250 kvp x rays (half-value-layer of the order of 0.9 mm copper) at a dose rate of about 110 R/min. Observations of chromosomes were made on each sample at intervals 24-144 hr after irradiation. The percentages of giant cells obtained at different intervals after x irradiation showed that 8n cells reached 64% by 48 hr after x irradiation. After 48 hr, the 8n cells decreased and cells with higher ploidies (16n, 32n, etc.) predominated. The 8n-64n cells accounted for approximately 80% (74-84 %) of mitoses observed at each interval of 48-144 hr after irradiation. One type of aberration the polycentric chromosome, found in the giant cells has not been reported previously. From the results, it was concluded that induction of bilaterally identically-symmetrical chromosomes in giant cells by x rays is not a spontaneous but a complex process involving a series of cytological mechanisms. (P.C.H.)

10851 ABSCOPAL STIMULATION OF THE THYMUS OF RATS BY EXPOSURE OF THE HEAD TO X-RAYS. Dalia Maor and Peter Alexander (Weizmann Inst. of Science, Rehovoth, Israel and Atomic Energy Commission, Rehovoth, Israel). Nature, 205: 40-2(Jan. 2, 1965).

Radiation effects on thymidine uptake, alkaline ribonuclease (RNase) content, and DNA content in the thymus and spleen of rats by exposure of the head were investigated. 24 hr after irradiating the head of rats with 1000 R there was a pronounced increase in the rate of incorporation of thymidine into the DNA of the thymus and in the RNase content of the spleen. The RNase activity of the thymus was also substantially higher at 24 hr, but the dramatic increase was only seen later in this organ. After 250 R to the head, increase in thymidine uptake in the thymus was already apparent at 2 hr, and at 19 hr the rate was close to its maximum value. The effect began to disappear on the fourth day after irradiation. However, no significant change in the thymidine uptake of the spleen was observed at any time although in this organ the RNase content was greatly increased by head irradiation. It is speculated that the increased rate of thymidine incorporation probably represents a true increase in the rate of DNA synthesis of certain thymus cells after head irradiation. (P.C.H.)

10852 DOSE RATIO OF X-RAYS TO FAST NEUTRONS IN PRODUCING DOMINANT LETHALS IN FLOUR BEETLES, TRIBOLIUM CASTANEUM. Howard E. Erdman (General Electric Co., Richland, Wash.). Nature, 205: 99-100(Jan. 2, 1965). (HW-SA-3719)

The dose ratio of 250 kv x rays and fast neutrons of mean energy 4.6 Mev for 50% dominant lethals in flour beetles, Tribolium castaneum, observed during two weeks post-irradiation are reported. The term dose ratio is used since dose-response curves (dominant lethals) were of the multi-hit type curves for x rays and one-hit type for fast neutrons. Fast neutrons were found to be 2-3 times more effective than x rays in producing 50% dominant lethality. The mean dose ratio of 2.4, which produced 50% dominant lethals in Tribolium, corresponds with the value of 3.4 in Drosophila. (P.C.H.)

10853 CIRCULATING STEM CELLS: VARIATION WITH DURATION OF PARTIAL BODY X-IRRADIATION. Samuel Hellman (Yale Univ., New Haven). Nature, 205: 100-1 (Jan. 2, 1965).

An experiment was made to observe the effects of the duration of partial body irradiation on the number of circulating stem cells to see whether these changes in the leukocyte levels reflect changes in stem cells. Mice were exposed to 900 R with the left lower extremity shielded, to determine whether stem cells from the unirradiated extremity would circulate, and colonize the spleen. The duration of radiation exposure was varied. Control animals receiving 900 R whole-body irradiation without limb shielding demonstrated a mean spleen colony count of 0.46 (±0.09) when the radiation duration was 1.4 min compared to a value of 25.2 ± 2.4 for shielded animals. When the duration was extended to 86 min, the mean spleen colony rose to 3.3 ± 1.6 for unshielded animals and 13.9 ± 1.7 for shielded ones. The results were consistent with the hypothesis that stem cells do circulate from the unirradiated limb and colonize the spleen. (P.C.H.)

10854 DELINEATION OF THE THYMIC AND BURSAL LYMPHOID SYSTEMS IN THE CHICKEN. Max D. Cooper, Raymond D. A. Peterson, and Robert A. Good (Univ. of Minnesota, Minneapolis). Nature, 205: 143-6(Jan. 9, 1965).

A combination of sub-lethal x irradiation with bursectomy, thymectomy, or both in the immediate post-hatching period in chickens was used to produce on experimental model of agamma globulinemia and to define the immunological function of the thymic and bursal systems in chickens. The findings suggest that the thymic-dependent tissue is basic to immunological recognition and that it interacts with the bursa-dependent lymphoid tissue that might be termed the production system for antibody. It is postulated that immunological deficiency in mammals following removal of the thymus or appendix may be affected by thymic- or appendix-dependent immunological recognition. (C.H.)

10855 THE RELATIONSHIP BETWEEN THE RADIOSENSITIVITY AND THE SIZE OF TUMORS IRRADIATED IN A STATE OF HYPERMETABOLISM INDUCED BY 3,5,3-L-TRIIODOTHYRONINE. E. Siracka and J. Siracky (Oncological Research Inst., Bratislava). Neoplasma, 11: 269-73(1964).

The radiation response of the Jensen sarcoma was followed in relation to the size of transplanted tumors irradiated in a hypermetabolic state induced by application of the thyroid hormone 3,5,3-L-triiodothyronine (T3). The sarcoma was transplanted to the inner side of the right hind limb of adult male Wistar rats, having an average weight of 160 g, in a 0.5-ml inoculum (6.5×10^7 cells). The 42 animals which developed tumors were divided into two main groups, one receiving x-ray therapy (Group I) and the other x-ray therapy combined with T3 injection (Group II). Each group contained two subgroups, one with small tumors (mean size 1 cm^3) and the other with large tumors (mean size 10 cm^3). T3 was administered subcutaneously to the animals in Group II in doses of 1 mg/kg body weight for 3 consecutive days. The growth of tumors was no more rapid in T3-treated rats than in the animals in Group I. The rats were exposed to 60-kv x rays for four consecutive days with doses of 1000 R daily. X-ray therapy was first administered to the rats in Group II on the day of the last T3 injection. The tumors were checked for size on the first, sixth, tenth, and 17th

days after termination of x-ray therapy. The small tumors of the controls showed an increase in size, whereas the small tumors of the animals treated with T3 decreased in size; the same was found with the large tumors. X-ray therapy failed to impede the growth of either the large or small tumors, the continued growth of the small tumors being much more rapid than that of the large. Although small tumors under T3 treatment also continued to grow during x-ray therapy, they decreased in size after the termination of irradiation. Large tumors irradiated in a hypermetabolic state continued to grow even after termination of x-ray therapy and exhibited such a marked tendency for exulceration that they could not be properly evaluated up to the 17th day, as were the other groups. It was concluded that the increased consumption of oxygen in tissues induced by a hypermetabolic condition is an important factor in radiosensitivity. Conversely, a diminished oxygen supply results in a lower degree of radiosensitivity. (BBB)

10856 TRANSFER BY CELL-FREE FILTRATE OF La VUFB LEUKEMIA, ORIGINALLY INDUCED BY X-RAY IRRADIATION. [PART] II. J. Libansky and M. Laznicka (Inst. of Hematology and Blood Transfusion, Prague). Neoplasma, 11: 379-84(1964).

The successful transfer by cell-free filtrate (CFF) of the mouse leukemia originally induced by x irradiation is described. This leukemia was induced in mice of the C57B1 strain, and transferred by means of CFF to newborn as well as to adult mice of the same strain. Transfer of this leukemia was also made by means of CFF to the CBA strain of mice, which proved very successful since in up to 100% of inoculated mice leukemia appeared with a shortened latent period of about 2 to 3 months. Within 6 weeks the spleen of the recipient mice became palpable (when newborn mice had been inoculated), and within 9 weeks the first animals died of leukemia. Within 7 to 14 days after the spleen was found to be enlarged leukocyte counts ranged from 40,000 to 60,000 and even up to extreme counts of over 400,000 in the terminal stage. Latency period was defined as the interval elapsed between the inoculation of CFF and the first clinical manifestations of the disease (palpable enlarged spleen); the period between the first finding of these pathologic manifestations and the death of the experimental animal was denoted as the stage of clinical manifestation or as the stage of full activity of the disease. This second stage lasted 2 to 5 weeks; the spleen gradually increased in size, leukocyte counts rapidly rose in the peripheral blood, and in the terminal stages, a state of inanition usually appeared. The duration of the period of fully developed disease, i.e., from the time at which splenomegaly was observed to death, is in almost all affected animals the same; it is only the latency period that varies, being 6 weeks to 5 months. Besides newborn mice, in the third passage, adult CBA mice were also used; they were inoculated with 0.3 ml of CFF per mouse, injected intraperitoneally. In adult CBA animals also the leukemia could be induced by a cell-free filtrate. Thus mice of the CBA strain appear to be more suitable subjects than C57B1 mice, in which the leukemia was originally produced. (BBB)

10857 DELAYED EFFECTS OF RADIATION ON THE HUMAN CENTRAL NERVOUS SYSTEM. EARLY AND LATE DELAYED REACTIONS. Peter W. Lampert and Richard L. Davis (Armed Forces Inst. of Pathology, Washington, D. C.). Neurology, 14: 912-17(Oct. 1964).

Two case histories are reported that emphasizes the effects of radiation on the human central nervous system Differences between the early and the delayed reactions are discussed and the presence of hypertrophic neurons in irradiated cortex is reported. Morphological characteristics of brain cells exposed to radiation doses of 2,500 R and 12,000 R are compared. (TCO)

10858 OCULAR CHANGES IN A-BOMB SURVIVORS EXPOSED DURING INFANCY. S. Toda, Y. Hosokawa, K. Choshi, A. Nakano, and M. Takahashi (Hiroshima Univ.). Nippon Ganka Kiyo, 15: 96-103(Mar. 1964). (In Japanese)

From 1958 to 1959 ophthalmologic examinations were performed on 115 junior and senior high school students who were exposed to the atomic bomb in Hiroshima during infancy, and on 24 controls. No marked differences in ocular diseases were observed between the exposed group and the control group except for lenticular changes. No significant differences in the amplitude of accommodation were observed between the group exposed within 1.5 km of the hypocenter and the control group. Lenticular changes common to the control group were first excluded from lenticular changes observed in the exposed group. By studying the relations between the remaining lenticular changes, that is, changes specific to the exposed group, and exposure distance, the clinical findings characteristic of atomic bomb cataract were obtained. The incidence of this cataract in the survivors who were distally exposed to the atomic bomb during infancy was lower than the heretofore reported incidence of atomic bomb cataract among those exposed during adulthood. The incidence of this type of cataract observed in youths 15 to 18 yr of age was 55.6% for those exposed within 1 km, 50.0% for those exposed within 1.2 km, 22.2% for those exposed within 1.4 km, and 12.0% for those exposed within 1.6 km of the hypocenter. The incidence markedly decreased to 1.5% for those exposed between 1.6 and 2.0 km of the hypocenter and no confirmed cases of atomic bomb cataract were found among those exposed beyond 2.0 km of the hypocenter. Atomic bomb cataract observed in youth was mild in severity and no severe cases with an opacity diameter of several mm were detected. (BBB)

10859 SPERMATOGENESIS OF THE SILKWORM AND ITS BEARING ON THE RADIATION INDUCED STERILITY. Toshihiko Sado (National Inst. of Genetics, Misima, Japan). Nippon Idengaku Zasshi, 36: Suppl., 136-51(Dec. 1961).

The correlation between the developmental stages of larvae and the germ cell stages in the testis was investigated in order to obtain basic knowledge required for mutagenesis work with the silkworm. The duration of each stage in spermatogenesis of the silkworm was estimated from the time table of the first appearance of cells in successive stages. It was noted that meiotic prophase takes about 10 days but late meiotic stages proceed within a short time. Results of histological examinations of irradiated testes of the silkworm showed an extreme sensitivity of secondary spermatogonia to the killing effect of x rays. Spermatocytes at late meiotic stages were found to be more sensitive to irradiation than those at synaptic and pachytene stages. In the silkworm, sterility due to the destruction of late spermatogonia is not detectable, even though the cells are easily killed by radiation. Pronounced sterility after irradiation in the early fifth instar occurs as a result of damage to late meiotic stages, especially in late prophase. The results are discussed in relation to similar ones in mice and Drosophila, and it is shown that a consistent picture of radioinduced sterility in animals can be inferred. (auth)

10860 THE RELATIVE BIOLOGICAL EFFECTIVENESS OF 200 kv X-RAYS, ^{60}Co γ-RAYS, 15 mv X-RAYS AND 15 Mev ELECTRONS ON THE TESTIS OF THE MOUSE. THE FIRST REPORT. Shigeaki Okamura and Hiroshi Nakamura (Kyushu Univ., Fukuoka, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 189-93(May, 1963). (In Japanese)

The relative biological effectiveness of 200-kv x rays, ^{60}Co γ rays, 15-Mv x rays, and 15-Mev electrons was determined by the testicular atrophy of the mouse. Groups of 10 mice ($CF\#_1$ male mice) were exposed to graded doses of the irradiations (50, 70, 100, 140, 200, 300, 400, 500, 630, 800, 1000R). To protect from lethal effects of total-body irradiation, only the lower pelvis, scrotum, and tail were included in the radiation field. Four weeks after exposure, both the irradiated and unirradiated mice were killed, their testes were dissected out, and the wet weights were determined. The relation between the dose of irradiation and degree of testicular atrophy was exponential over a range of 70 to 630 Rad. Testicular weight-loss was expressed as percent of control weight and regression lines for response as a function of dose were calculated. Two types of RBE were calculated. Both were smaller than

1.00, and agreed with the generally accepted theory that RBE is influenced by LET. (auth)

10861 NEUTRON FLUX DISTRIBUTION IN WATER PHANTOM. Kiyomitsu Kawachi and Yuji Takaku (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1488-92(Mar. 1964). (In Japanese)

To calculate the fast and thermal neutron flux distribution, a two-group diffusion equation was applied to the one-dimentional slab water phantom irradiated by an infinite plane neutron source. The group constants such as diffusion coefficients, Fermi age, and diffusion length were given by ANL-5800. The calculated results were compared with direct measurements obtained by irradiating some water phantoms by a Ra-Be source and measuring the thermal neutron flux distribution by the activation of Au foils. The exponential attenuation curves of the fast neutron fluxes and build-up curves of the thermal neutron fluxes for water phantoms of several thicknesses were obtained by both methods. (auth)

10862 A LONG-TERM OBSERVATION ON THE EFFECT OF X-RAY IRRADIATION FOR EXPERIMENTAL CHRONIC INFLAMMATION. Yoshio Takahashi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 27-33(Apr. 1964). (In Japanese)

The long-term observation of x-ray effects on the chronic inflammation produced by B.C.G. vaccination intracutaneously into the backs of rabbits is reported. Repeated x irradiation and histological studies were carried out for 13 weeks. The first animal group was treated with 100 R once a week for 11 weeks, the second group with 50 R once a week for 13 weeks, and the third group without irradiation. Histological studies revealed almost no differences between the three groups in the early stage. After 13 weeks, the first group showed complete fibrosis, the second group showed medium fibrosis, and the last group revealed slight fibrosis. From the results, it was recommended that adequate x irradiation should be given according to the stages of the chronic inflammation. (auth)

10863 CHANGES OF STRUCTURE AND FUNCTION OF MOUSE LIVER MITOCHONDRIA AFTER WHOLE-BODY IRRADIATION. Hiroyuki Urakami (Okayama Univ., Japan). Okayama Igakkai Zasshi, 76: 13-19(Mar. 1964). (In Japanese)

The mechanism of action of x irradiation on the function and structure of mitochondria was studied by analysis of mitochondrial swelling-shrinkage, oxidative phosphorylation, Fe-ion-induced swelling, and Fe-ion-induced lipid peroxidation. Mitochondria were isolated from the liver of mice 3, 6, 12, 24, and 48 hr after whole-body irradiation at 500 R, and from nonirradiated mice. Oxidative phosphorylation in mitochondria was reduced 50% after irradiation for 6 hr and returned to normal after 24 hr. Respiration of mitochondria was decreased by 40% after irradiation for 6 hr and remained at this low level for 48 hr. The degree of swelling–shrinkage of mitochondria (about 20% change in volume, as measured by light scattering) was reduced 6 to 12 hr after irradiation and then recovered to the control level after 24 hr. Swelling, as measured by the absorbancy at 520 mμ, and lipid peroxidation in mitochondria induced by Fe ions were increased in initial velocity and in extent by irradiation. These increments were maximum at 12 hr. The results suggest that the increment of peroxidizable lipid of mitochondria is related to the uncoupling of oxidative phosphorylation seen with irradiation. Possible mechanisms of uncoupling of oxidative phosphorylation by irradiation are considered. (BBB)

10864 INJURIES FROM ENERGY-RICH RADIATION AND THEIR TREATMENT. A. Morczek (Strahleninstitut und der Strahlentherapeutischen Klinik der Medizinischen Akademie, Magdeburg, Ger.). Pharmazie, 19: 181-6(Aug. 1964). (In German)

The main causes of exposure to radiation are technical failure of radiation protection equipments, laboratory accidents with radioactive materials, reactor incidents, or nuclear warfare. Radiation injuries can occur along with open wounds or fractures, burns, infections, or with poisonings of various types. The radiation effects may be internal or affect only the body surface. Incorporation of radioactive substances may take place by way of the gastrointestinal tract, lungs, or through the skin. The type and degree of injury will be influenced by the total radiation dose, its distribution and quality, and by the retention time within the body. Effects of whole-body radiation are related to the total dose, but there are no detectable effects after exposure to 25 rem. Some effects appear at 100 rem, 400 rem is the median lethal dose, whole 700 rem is the lethal dose. Primarily, exposure to ionizing radiation may cause injuries to hematopoietic organs and blood capillaries, the gastrointestinal tract, water and electrolyte disturbances, skin, and the central nervous system. General methods and procedures for treatment or regulation of the injuries caused by radiation are discussed briefly. Methods for decontamination and removal of radioisotopes incorporated into the body are outlined, and, finally, general procedures for treatment of multiple injuries and their complications are described. (BBB)

10865 GRANULOCYTOPOIESIS AND EFFECTS OF IRRADIATION. Harvey M. Patt and Mary A. Maloney (Argonne National Lab., Ill.). Proc. Congr. Intern. Soc. Hematol., 9th, Mexico City, 1962, 3: 331-4(Pub. 1964).

The development of radioinduced granulocytopenia is examined in several species (dogs, monkeys, mice, rats, and rabbits) in light of granulocyte kinetics. The decline in blood granulocytes after whole-body x irradiation was found to correspond in all species studied to the time usually required for maturation and release from bone marrow of post-mitotic granulocytes. Development of granulocytopenia was dependent on the reservoir of mature cells in the bone marrow. Recovery after doses of 500 to 600 R, which leads to nearly complete granulocyte depopulation of the marrow, depended on the integrity of the stem cell population and was more rapid in mice, rats, and rabbits than in monkeys and dogs after comparable exposure. The recovery phenomenon is explained by species differences in circulating granulocyte mass. (H.M.G.)

10866 ESTABLISHED BONE MARROW CELL CULTURES WITH HIGH DEGREE OF IRON INCORPORATION. Giancarlo Rabotti and Ioulious Iossifides (Jefferson Medical Coll., Philadelphia). Proc. Intern. Congr. Hematol., 9th, 1962, 3: 401-4(1964).

Iron-59 metabolism was studied in short-term cultures of cells derived from established cultures of human bone marrow cells. Cells from 2 cell lines had similar Fe uptake at 24 and 48 hrs after culture but 1 cell line showed significantly higher Fe uptake than the other at 72 and 96 hrs after culture. The morphological characteristics of cells up to 85 passages are described. Data are included on the effects of 300 R x radiation on ^{59}Fe incorporation by erythrocytes in tissue cultures and fibroblasts. (C.H.)

10867 RADIATION EFFECTS OF IRON^{59} INCORPORATION. Edward L. Alpen and S. J. Baum (Naval Radiological Defense Lab., San Francisco). Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 3: 405-14(1964).

Results are reported from studies on the effects of single or repeated exposures to 300 R x radiation on incorporation of tracer doses of ^{59}Fe into peripheral erythrocytes of rats. Erythrocytes labeled with ^{32}P were used to measure the erythrocyte volumes of the rats on the day of ^{59}Fe injection and measurements were made of plasma Fe content and ^{59}Fe activity and ^{32}P-labeled erythrocyte dilution volumes. Rats irradiated with a single dose of 300 R showed a decrease in Fe metabolism with a maximum about 48 hr post-irradiation and a return to normal values after about 5 days. Repeated exposures significantly decreased the amount of ^{59}Fe incorporated and increased the time necessary for recovery. A mathematical model is presented for use in estimating non-recoverable damage to the hematopoietic system in irradiated rats exposed to repeated doses of 300 or 400 Rads x radiation. (C.H.)

10868 TRITIATED THYMIDINE UPTAKE BY THE RAT SPLEEN AS A MEASURE OF ERYTHROPOIESIS. Howard L. Alt, Efstratios S. Kurtides, Walter A. Rambach, and John C. Wurster (Northwestern Univ., Chicago).

Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 3: 459-65(1964).

Tritiated thymidine was used as a tracer in studies on the effects of erythropoietin on erythropoiesis in the spleen of rabbits. Although the spleen normally contains few erythroid elements, erythropoietin stimulated it to revert to an actively proliferating erythropoietic organ. Results are reported from studies on the effects of a single large dose of erythropoietin or x irradiation and erythropoietin on erythropoietic functions of the spleen. (C.H.)

10869 EFFECT OF HYPOPHYSECTOMY AND ADRENALECTOMY ON THE LENGTH OF SURVIVAL TIME AFTER X-IRRADIATION IN THE GOLDFISH, CARASSIUS AURATUS. Hisami Etoh and Nobuo Egami (National Inst. of Radiological Sciences, Chiba, Japan). Proc. Japan Acad., 39: 503-6(1963).

Changes in the dose-survival time relation after x irradiation in goldfish following hypophysectomy or adrenalectomy were investigated. Survival times of irradiated goldfish that were hypophysectomized, adrenalectomized, or hypophysectomized but injected with ACTH were recorded. It was concluded that the hypophyseal-adrenal system plays an important role in prolonging the life of x irradiated fish and that the removal of either the pituitary or the adrenals prior to irradiation obliterates the dose-independent range in the dose-survival time-curve in goldfish as in mammals. (P.C.H.)

10870 MUTATION WITHOUT SEGREGATION. H. E. Kubitschek (Argonne National Lab., Ill.). Proc. Natl. Acad. Sci. U. S., 52: 1374-81(Dec. 1964).

Evidence is presented for the absence of a segregational division when mutation to T5 resistance is induced by light in E. coli cultures to which acridine orange is added. It is further shown that this result and the kinetics of phenotypic expression of resistance to bacteriophage T5 can be understood by postulating that mutation takes place in a master strand of DNA that specifies the coding sequence of both daughter strands and that its complementary strand specifies the coding sequence of messenger RNA. (H.M.G.)

10871 PRELIMINARY OBSERVATIONS ON SPONTANEOUS AND RADIATION-INDUCED LEUKEMIA IN GERM-FREE MICE. H. W. Walburg, Jr., A. C. Upton, R. L. Tyndall, W. W. Harris, and G. E. Cosgrove (Oak Ridge National Lab., Tenn.). Proc. Soc. Exptl. Biol. Med., 118: 11-14(Jan. 1965).

Germfree ICR and RF mice x irradiated in a single exposure to 300 to 900 R were observed for leukemia for periods up to 10 months after irradiation, along with nonirradiated controls. Preliminary data indicate that the cumulative incidence of leukemia in the irradiated germfree mice is as high as, or higher than, in the irradiated conventional mice. The incidence is higher in both irradiated groups than in the unirradiated germfree and conventional controls, which do not differ in spontaneous leukemia incidence. All leukemias examined thus far histopathologically have been lymphosarcomas. Tissues of a germfree RF mouse with x-ray-induced leukemia contained tailed virus-like particles similar to those noted in conventional mice and associated with transmission of the disease. Both germfree and conventional mice with leukemia showed renal glomerulosclerosis. (auth)

10872 APROPOS OF THE HARMFUL EFFECTS OF RADIATIONS. Progr. Med., 17: 489-91(July 31, 1961). (In Italian)

The hazards of man-made radiation sources to the human race are discussed. (BBB)

10873 THE RADIOSENSITIVITY OF THE LYMPHOCYTES OF THE RABBIT APPENDIX. Peter P. H. de Bruyn, M. Marcella Tornova-Svehlik, and J. H. Venter (Univ. of Chicago). Radiation Res., 24: 15-31(Jan. 1965).

Measurements of the lymphatic tissue volume of the rabbit appendix before and after x irradiation show an exponential relationship between x-ray dose and lymphatic destruction. The configuration of the regression curves indicates the presence of a group of lymphocytes in the rabbit appendix highly radioresistant. After total-body irradiation this population is estimated to constitute from 13.4 to 28.3% of the total amount of lymphocytes present. A comparison between the effect of x irradiation on animals of which the appendix alone is irradiated and on animals receiving total-body irradiation (sham shielding) shows the presence of an indirect effect that increases appreciably the lymphocyte destructive consequences of total-body x irradiation. (auth)

10874 THE EFFECT OF X-IRRADIATION ON THE ACTIVITIES OF SOME LYSOSOMAL HYDROLYSIS OF HEART TISSUE. G. L. Sottocasa, G. Glass, and B. de Bernard (Universita, Trieste, Italy). Radiation Res., 24: 32-42(Jan. 1965).

Suspensions of heart tissue lysosomes were used to study radiation damage on lysosomal structures in vitro. Irradiation was carried out on: lysosomes separated with the mitochondria from heart tissue homogenate and suspended in 0.25M sucrose solution; the homogenate itself; and slices of heart tissue. Effects of x rays on lysosomal structures were determined by following the activity alterations in β-glucuronidase and β-galactosidase. X-irradiation of heart homogenate and of heart lysosome suspensions did not produce any modification of the specific activities of β-glucuronidase and β-galactosidase when the maximal dose used was 440,000 R. On the other hand, heart slices irradiated in vitro with doses from 10,000 R to 76,500 R showed an increase in specific activity of the lysosomal enzymes. It is concluded that the effect of x rays on the release of lysosomal enzymes is mediated by conditions that require structural integrity of the cell rather than being a direct action on lysosomal membranes. (H.M.G.)

10875 THE EFFECTS OF X-IRRADIATION ON MALE FERTILITY IN THE GUINEA PIG. SEMEN PRODUCTION AFTER X-IRRADIATION OF THE TESTIS, OF THE BODY, OR OF THE HEAD. M. Freund and F. J. Borrelli (New York Medical Coll., New York). Radiation Res., 24: 67-80 (Jan. 1965).

Semen was collected by electroejaculation from guinea pigs before and after x irradiation (300 R): of the body; of the testis (head and body shielded); or of the head and body (testes shielded). Each of the three irradiation treatments resulted in a marked depression in sperm output. Sperm output was markedly depressed (below 1 million cells per ejaculate) for 12 weeks after whole-body irradiation, for 6 to 7 weeks after testis irradiation (head and body shielded), and for 1 week after head and body irradiation (testes shielded). Recovery to preirradiation levels of sperm output took 21 weeks after testis irradiation (head and body shielded) and 47 weeks after head and body irradiation (testes shielded). The existence of an abscopal effect of irradiation on spermatogenesis was indicated. Thus, the abscopal effect of radiation on sperm production was not shown to be due to direct radiation effects on the hypothalamic-hypophyseal structures. (auth)

10876 HUMAN CELL SURVIVALS AFTER PULSED X-IRRADIATION. S. L. Hood and Grace Norris (Kettering Research Lab., Yellow Springs, Ohio). Radiation Res., 24: 81-7(Jan. 1965).

Normal and malignant human cell cultures were examined for variations in lethality caused by x irradiation when the x-ray beam was pulsed in the range 1 pulse per minute to 50,000 pulses per second. No variation due to pulsing was found. (auth)

10877 ACTION OF IONIZING RADIATION ON PHOTOSYNTHETIC REACTIONS OF ISOLATED CHLOROPLASTS. W. Simonis and W. Fuechtbauer (Universitat, Wurzburg, Ger.). Radiation Res., 24: 88-95(Jan. 1965).

Noncyclic photosynthetic phosphorylation with accompanying TPN reduction and oxygen evolution was measured in irradiated isolated chloroplasts. Different kinds of cyclic photophosphorylation were also determined. The noncyclic phosphorylation was much more sensitive to x rays than the TPN reduction and oxygen evolution coupled to it. This result was obtained whether or not the phosphorylation was fully coupled to the electron flow. The radiosensitivity of the phosphorylations studied was noncyclic greater than cyclic with flavin mononucleotide, or vitamin K_3 greater

than cyclic with phenazine methosulfate. Conclusions from the results are discussed with reference to the conceptions of the pathways of photophosphorylation reactions. (auth)

10878 EFFECT OF CHRONIC GAMMA RADIATION ON AIRBORNE INFECTION OF MICE WITH LISTERIA MONOCYTOGENES. R. H. Stewart, J. F. Pribnow, and M. S. Silverman (Naval Radiological Defense Lab., San Francisco). Radiation Res., 24: 96-107(Jan. 1965).

The susceptibility of mice to an airborne infection with Listeria monocytogenes increased after continuous exposure to γ radiation delivered at 1.0 to 1.5 Rads/hour. Susceptibility increased with increase in the total radiation dose. The $LD_{50(30)}$ for nonirradiated mice was 5.7×10^5 organisms, whereas after exposure to 500 and 1500 Rads it dropped to 1.8×10^5 and 1.2×10^5, respectively. Further exposure to 2000 Rads decreased the $LD_{50(30)}$ to 4.1×10^4. After 2500 Rads it was 1.7×10^4, a 33-fold increase in susceptibility compared to that found in the nonirradiated mice. The fate of inhaled L. monocytogenes in the lungs of irradiated (2000 Rads) and nonirradiated mice was investigated at 4 hours after infection. Irrespective of the aerosol challenge dose, the lungs of irradiated mice reduced bacterial numbers by 61% in this time, compared to 80% for the nonirradiated animals. Bacterial dissemination in the organs of mice challenged with sublethal and lethal doses of the organism was also determined at 2-day intervals. After sublethal aerosol challenge, bacterial counts on homogenates from the lung, liver, and spleen indicated that a more rapid proliferation of the organism occurred in the organs of ^{60}Co irradiated mice. Furthermore, the ultimate disappearance of L. monocytogenes from the lung and spleen of irradiated mice was delayed by 2 to 4 days in comparison to the removal seen in nonirradiated animals. After challenge with lethal numbers of L. monocytogenes, bacterial proliferation rates in the organs of irradiated and nonirradiated mice were comparable. However, deaths among irradiated mice occurred on days 3 and 4, whereas in the nonirradiated group they were recorded on days 5 and 6. (auth)

10879 CHROMOSOME ABNORMALITIES IN LIVER AND MARROW OF MICE IRRADIATED WITH FAST NEUTRONS, GAMMA RAYS, AND X-RAYS: EFFECT OF DOSE RATE. Peter C. Nowell, David E. Craig, Frederick A. Matthews, and Leonard J. Cole (Univ. of Pennsylvania, Philadelphia and Naval Radiological Defense Lab., San Francisco). Radiation Res., 24: 108-18(Jan. 1965).

Low-dose-rate irradiation with either γ rays (1000 Rads) or fast neutrons (240 Rads or 480 Rads) resulted in fewer cells with chromosome abnormalities in mouse liver and bone marrow than did comparable high-dose-rate irradiation with x rays (500 Rads) or neutrons (200 Rads or 320 Rads). Neutrons generally produced more aberrant cells than did the low-LET radiations, but a dose-rate effect was apparent with both types of radiation. Liver cells with unstable chromosome aberrations, as well as total aberrant liver cells, were less frequent in the low-dose-rate groups. Possible reasons for the observed dose-rate effects are considered, as well as limitations of the experimental system, in which carbon tetrachloride was used to initiate liver cell mitosis. The hepatic results were influenced by the damaging effect of the CCl_4 on liver chromosomes and by the presence of dividing myeloid cells in the liver preparations. The marrow data were affected by cell selection phenomena during postirradiation regeneration. (auth)

10880 EFFECT OF X-IRRADIATION ON THE INTESTINAL EPITHELIUM OF THE GOLDFISH CARASSIUS AURATUS. II. INFLUENCE OF TEMPERATURE ON THE DEVELOPMENT OF HISTOPATHOLOGICAL CHANGES IN THE INTESTINE. Yasuko Hyodo (National Inst. of Radiological Sciences, Chiba, Japan). Radiation Res., 24: 133-41(Jan. 1965).

The effect of post-irradiation temperature on survival time and rate of development of intestinal damage was studied in goldfish given 8 kR x radiation at room temperature. A majority of goldfish that had been exposed to whole-body irradiation with 8 kR of x rays survived for more than 100 days if they were kept at 4°C, whereas most of similarly irradiated fish died within 10 days if they were kept continually at 22°C. The cool thermal surroundings inhibited the development of histological damage of the intestinal epithelium that occurred in warm environment. If irradiated fish that had been kept at 4°C for 40 or 100 days were transferred to 22°C, the fish died within about 10 days, exhibiting characteristic damage of the intestinal epithelium. (H.M.G.)

10881 THE INACTIVATION OF MITOCHONDRIAL ENZYMES BY GAMMA RADIATION IN VITRO. I. D. Clarke and Jill Lang (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Radiation Res., 24: 152-53 (Jan. 1965).

The inactivation of mitochondrial enzymes by γ-radiation was investigated in vitro, and the relative radiosensitivity of the phosphorylating system was compared with that of the electron-transport chain. The presence or absence of oxygen during irradiation was investigated in conjunction with the nutritional status of the animal providing the mitochondrial preparation. The radiation sensitivity of parts of the electron-transport chain and the phosphorylative sites associated with them were determined on the basis of using two substrates, succinate and β-hydroxybutyrate. In general, the oxidative system has proved to be more resistant to radiation than has the phosphorylative system for both substrates. The P/O ratio for β-hydroxybutyrate fell more rapidly with dose than the ratio for succinate, indicating that the first phosphorylating site was more readily uncoupled than the two sites that occurred later in the chain. The nutritional status of the animal did not influence the radiation response of the mitochondrial enzymes, although the ability of the mitochondria to oxidize succinate was reduced. (auth)

10882 THE EFFECTS OF PRENATAL X-IRRADIATION ON ACQUISITION, RETENTION, AND EXTINCTION OF A CONDITIONED EMOTIONAL RESPONSE. Joseph C. Sharp (Walter Reed Army Inst. of Research, Washington, D. C.). Radiation Res., 24: 154-7(Jan. 1965).

Female albino rats irradiated on the sixteenth day of prenatal development were trained on an emotional conditioning procedure superimposed on a lever-pressing performance for water reward. Acquisition of the conditioned emotional response (CER) by the irradiated animals was demonstrated at shock intensities and durations consistently below those required to establish the CER in a comparable nonirradiated control group. At 60 days and again at 175 days after acquisition of the CER by all animals, retention tests showed no differences between the groups, although the nonirradiated control animals were more resistant to extinction of the CER than the irradiated rats. (auth)

10883 CRITICAL REMARKS ON X IRRADIATION OF HEMANGIOMAS IN CHILDHOOD, WITH REFERENCE TO UNEXPECTED DELAYED RADIATION INJURIES. Vaclav Bek and J. Kolar (Charles Univ., Prague). Radiobiol. Radiother., 3: 429-36(1962). (In German)

Post-treatment results from 571 children irradiated for 760 hemangiomas from 5 to 15 yr ago were examined for evidence of delayed radiation injuries. In 7.2% of the children that had planotuberous and tubernodosus hemangiomas, and in 13.2% of the cases that had naevi telangiectatus, radiation injuries that involved changes in the skin, subcutaneous tissues, and adnexus were found. Most of these changes were caused by large radiation doses. Mammary hypoplasia was noted in one girl. Unexpectedly, in 9% of the irradiated children radioinduced skeletal changes were found. In 80% of these there were no external symptoms to indicate the bone alterations that were discovered by x-ray examination. These were similar to other typical radioinduced bone changes, including aberrations of bone structure in the epiphyseal and metaphyseal regions, atypical deformations and shortening of the cortical bones, joint defects, formation exostoses, growth disturbances in the skull, ribs, teeth, etc. The incidence of changes in the epiphyseal regions approached 50%. In 12 children muscular dystrophies were found. In one group of 51 children who had been irradiated in the eye region two typical radioinduced cataracts were

detected, although there were no evidences of skin changes in the area irradiated. The possibility that radiation may be cancerogenic or have genetic effects should be considered very seriously when radiation of hemangiomas is planned. Children should not be irradiated with ^{60}Co or Ra, since gonadal damage may result. In view of the often spontaneous involution of hemangiomas in children, usually no treatment is required. Perhaps in 5 or 10% of these cases prompt early treatment with very small radiation doses may be justified. Extreme caution should be exercised, especially when the lesion is located in the facial region. Often under these conditions hemangioma growth can be retarded, and its involution induced. (BBB)

10884 LEUKEMIAS: ETIOPATHOGENESIS, EPIDEMIOLOGY, AND CLINICAL CHARACTERISTICS. M. Jamra, T. F. Lorenzi, and R. V. Milder (Universidade de Sao Paulo, Brazil). Rev. Paulista Med., 63: 1-43(July 1963). (In Portuguese)

The etiology of leukemias, including the possible role of natural and artificial sources of radiation, is discussed. (BBB)

10885 EVALUATION IN R_2 OF THE EFFECTS OF IONIZING RADIATION ON GENETIC VARIABILITY IN NICOTIANA TABACUM. D. Bagnara (CNEN, Rome), D. L. Palenzona, and G. Wittmer. Tabacco, 67: 707-8(Apr.-Sept. 1963). (In Italian)

A method using average estimates of genetic variances in R_2, by means of matrix calculations was applied to experimental data concerning three leaf characters in 3 varieties of N. tabacum, treated with 3 doses of x rays (9,000, 18,000, and 0 R). The results obtained show that genetic variance induced by ionizing radiations is larger than that estimable in control material and that there is a differential response between different varieties. (P.C.H.)

10886 HOST CELL REACTIVATION OF ϕX174 AT INTRACELLULAR UV IRRADIATION. Walter Sauerbier (Universität, Cologne). Z. Verebungslehre, 95: 145-9 (1964).

The DNA of phage ϕX174 is single stranded, but upon infection of a bacterial host cell it is converted to a double-stranded replicative form (RF). Both the single-stranded DNA from mature phage, and the RF are capable of infecting protoplasts leading to synthesis of mature ϕX174 phage particles. The uv sensitivity of the RF for successful protoplast infection is $\sim 1/10$ of the sensitivity for infection by single stranded DNA, as observed using protoplasts of Escherichia coli C, a strain known to perform host cell reactivation (HCR). The question thus arose whether HCR causes the reduced uv sensitivity of double-stranded ϕX174 DNA, HCR being an enzymatic mechanism repairing uv damage in the DNA of phages. The reduced uv sensitivity of the RF was investigated and evidence presented that HCR occurs in uv-irradiated double-stranded RF, but not with single-stranded ϕX174-DNA. Thus, if ϕX174-infected cells are uv irradiated about three min after the onset of phage development, HCR of the intracellular phage could be demonstrated. HCR of ϕX174 could be observed only in host bacteria able to reactivate phages T1 and λ. As with these two phages, HCR in ϕX174 could be inhibited by caffeine. Since no HCR could be observed if ϕX174 was irradiated extracellularly or immediately after infection, it seemed likely that only uv damage to the double-stranded replicative form of ϕX174 can be repaired by HCR. The tenfold difference in uv sensitivities for protoplast infection with single and with double stranded ϕX174 DNA must be largely due to HCR, and not to the double strandedness per se. According to values obtained with T1 and λ, HCR repairs between 80 and 90% of the otherwise lethal damage. If HCR repairs uv damage in the RF with equal efficiency, the uv sensitivity of the biological activity of single-stranded ϕX174 DNA should differ from the double-stranded form by a factor of only 1.5 to 2. (BBB)

10887 THE INFLUENCE OF γ IRRADIATION OF DRY SEEDS ON THE GROWTH, GRAIN YIELD AND QUALITY OF TRITICUM AESTIVUM. K. T. Schneider (Fruit and Food Tech. Research Inst., Pretoria). p.496-504 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963. (In Dutch)

In order to determine the influence of γ rays on dry seed of a commercial South African wheat cultivar and with the purpose of inducing mutations artificially, the cultivar Losper was exposed to γ rays from a ^{60}Co source. During March 1959, four seed samples of this cultivar were treated separately with doses of 10,400, 15,900, 20,000, and 27,000 R respectively. For each irradiation dose, about 150 gm of dry seed was treated and of each treatment a total of 320 seeds was planted in a randomized block design. Untreated seed of the same cultivar were used as controls. In the γ_1 generation several effects were observed. The period in days from planting to ears out increased significantly with increased irradiation doses. Up to 15,900 R about 82% of the plants emerged were normal, but then the percentage decreased to about 8 in the case of the highest dose of 27,000 R. There was a decrease in the average plant height and grain yield with increased irradiation doses. Increased irradiation doses resulted in an increase in protein content and a decrease in baking quality. In the γ_2 and γ_3 generations, deviations as described, no longer occurred and these progenies were uniform. The results indicate that phenotypical deviations, resulting from irradiation, can remain limited to the somatic tissue. The fact that the said changes disappeared with the death of the γ_1 indicate that only somatic mutations were obtained. These mutations retarded the development of the plants and were correlated with increased irradiation doses. The longer growing and assimilation periods of the material concerned did not result in higher grain yields, but caused an increase in protein percentage. This increase in protein can therefore be regarded as a secondary influence of the radiation and is not caused by gene or chromosomal mutations. It would also appear that identical phenotypes could result from mutations in either the somatic or gene tissues. (auth)

10888 THE INDUCTION OF CONTINUOUS VARIATION BY X IRRADIATION IN DROSOPHILA. J. M. Stevens and P. R. Le Roux (Univ. of Stellenbosch, South Africa). p.505-13 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

The induction of continuous variation in sternopleural and abdominal chaetae number consequential to the irradiation of chromosome II of Drosophila melanogaster was studied. Using an isogenic line that was obtained by the usual technique from an inbred line, two irradiation series, 500 and 1000 R were started. Each series comprised 25 lines characterized by having one specific chromosome II. The chromosome was kept exclusively in the male line and balanced against the CyL^4 inversion. It was thus protected from recombination and to a large extent from the action of natural selection. Males were irradiated and mated to CyL^4/Pm females having a homogeneous genetic background that was constantly renewed by a series of matings involving backcrossing to the isogenic line. After each irradiation the pairing affinity and lethality of the irradiated chromosome were tested. Only lethal-free chromosomes that did not impair fertility were kept. Mutations were thus allowed to accumulate in chromosome II and after every third or fourth generation of irradiation an assessment of the amount of variation produced in chaetae number was made by using a modified version of the diallel technique. In the 500 R series variation was detected in the number of abdominal chaetae at a dose of 3000 R and in sternopleural number at 4500 R. In the 1000 R series sternopleurals and abdominals responded at 9000 and 12000 R respectively. About one third of the induced phenotypic variation is heritable in the narrow sense and could thus be utilized by selection. The additive variation increased linearly with dose and it was estimated that the additive variance increment per roentgen was $(1.6 \pm 0.2)10^{-5}$ and $(3.7 \pm 1.4)10^{-5}$ for sternopleurals and abdominals, respectively. These values are considerably lower than those obtained by others but estimates are free from chromosomal and genic recombination effects. (auth)

10889 THEORETICAL CELL POPULATION KINETICS FOLLOWING IRRADIATION OF THE ROOT MERISTEM OF VICIA FABA. B. J. Shepstone and R. Oliver (Churchill Hospital, Oxford). p.526-35 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Explanations for the steady state for the meristem of irradiated Vicia faba roots are considered, based on compartment size control. The theoretical patterns following irradiation were compared with the experimental results. (P.C.H.)

10890 THE CONTRIBUTION OF CHARGE AND ENERGY MIGRATION PHENOMENA TO RADIATION INACTIVATION MECHANISMS IN ENZYMES. L. G. Augenstein and R. Mason (Michigan State Univ., East Lansing and Univ. of Sheffield, Eng.). p.23-8 of "Electronic Aspects of Biochemistry." New York, Academic Press, 1964.

A review is presented on the temperature dependence of the radioinduced inactivation in enzymes, and its deviation from the framework of the one-ionization model that forms the major mechanistic scheme for radiation inactivation of enzymes. It was concluded that for the usual temperatures at which inactivation experiments are carried out, only a small fraction of the inactivation should be attributed to ionizations per se (40-80% for radiations of high linear energy transfer, LET). If the temperature-independent component does include all inactivations resulting from ionizations, then it can be concluded that ionizations are of little consequence except in the inactivation of enzymes by such high LET radiations as carbon nuclei. Several questions arising from this are discussed. (P.C.H.)

10891 MEASUREMENT OF INTESTINAL DAMAGE FROM NEUTRONS, X-RAYS OR NITROGEN MUSTARD TREATMENT. M. F. Sullivan. 4p. (CONF-556-4)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

The plasma protein substitute, polyvinylpyrrolidone (PVP), was used to measure intestinal damage from x rays, neutrons, and nitrogen mustard in rats. The pattern of PVP excretion after neutron irradiation was similar to that following x irradiation but leakage occurred from lower doses, as expected. It is suggested that the reduced excretion in comparison to control values after low radiation doses of both x rays and neutrons is most probably related to hemodynamic changes in the enteric blood supply. The nitrogen mustard drugs produced clinicopathological effects similar to radiation. They also differed from radiation and from other members of that drug family in their predominate site of injury. Both cysteine and AET pretreatment reduced the quantity of PVP leaked into the intestine after x irradiation and nitrogen mustard. (P.C.H.)

10892 REGENERATION OF LOCALLY IRRADIATED BONE MARROW. I. DOSE DEPENDENT, LONG-TERM CHANGES IN THE RAT WITH PARTICULAR EMPHASIS UPON VASCULAR AND STROMAL EFFECTS. W. H. Knospe and J. Blom (Walter Reed Army Inst. of Research, Washington, D. C.). 6p. (CONF-556-9)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Studies were made to determine the minimum dose of x irradiation necessary to permanently depopulate the medullary cavity of a long bone of hemopoietic elements. The mechanism of the regeneration of marrow hemopoietic elements was included. Male Wistar rats weighing approximately 150 g were used. The limits of marrow regeneration after local irradiation was found to be between 2000 and 4000 R. At the 2000 R level hemopoietic regeneration seemed to be intimately connected with the regeneration of a marrow sinusoidal system approximating parenchymal-vascular interrelations seen in normal marrow. Reticulum cells seemed to occupy a critical role in the regeneration of sinusoidal structures. (P.C.H.)

10893 CHROMOSOME ABERRATIONS PRODUCED BY DIAGNOSTIC LEVELS OF X-RAY IRRADIATION. Roy Schmickel, Arthur Bloom, and Clayton Cisar. 15p. (CONF-556-15)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Studies were made in vitro to determine the frequency and type of chromosome aberrations produced by diagnostic, low energy x rays. The more complex abnormalities of the chromosomal type ween were dicentrics, rings, acentric fragments, and abnormally long chromosomes. The percentage of cells that contained any of these was found at increasing dose levels. Thus it would appear that these types of abnormalities are statistically reliable indicators of even low levels of radiation exposure. The results further suggest that leukocyte chromosome aberrations can be used as indicators of low level irradiation. At all exposure levels tested there were significantly higher numbers of chromosome aberrations in the irradiated cells than in the control. (P.C.H.)

10894 THE IMPORTANCE OF CELL POPULATION KINETICS IN DETERMINING RESPONSE TO IRRADIATION OF NORMAL AND MALIGNANT TISSUE. C. W. Gilbert and L. G. Lajtha (Christie Hospital and Holt Radium Inst., Manchester, Eng.). 51p. (CONF-456-5)

From 18th Annual Symposium on Fundamental Cancer Research and Cellular Radiation Biology, Houston, Tex., Mar. 1964.

Certain principles on which cell population models may be constructed are considered, experimental evidence for the existence of such cell populations are examined, and the various response patterns that such cell populations may exhibit following irradiation are discussed. It is demonstrated that the response of various cell populations to irradiation is determined to a great extent on their population kinetic pattern. (P.C.H.)

10895 THE EFFECT OF WHOLE BODY RADIATION ON THE ACID DEOXYRIBONUCLEASE (DNAase II) LEVEL OF SPLEEN OF Ha/ICR SWISS MICE. O. Pierucci (Roswell Park Memorial Inst., Buffalo). 12p. (CONF-556-17)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Following exposure of mice to sublethal doses of whole-body x radiation, the activity of acid deoxyribonuclease (DNAase II) increased in spleen and thymus. The increase of total activity was of the order of 80% after 300 R. No significant change of activity was observed in liver and in kidney. However, the increase in activity was not prevented by inhibitors of protein synthesis. The destruction of lymphoid tissues appeared directly related to the increase of the enzyme. Such increase was not specific for radiation since it was seen also after actinomycin D, puromycin, and hydrocortisone. It is stressed that these compounds repressed lymphoid tissues. Adrenal stimulation did not totally account for the effect of radiation. (P.C.H.)

10896 DISASSEMBLY OF MITOTIC ORGANELLES WITH SUBCELLULAR MICROBEAMS. Raymond E. Zirkle and Robert B. Uretz (Univ. of Chicago). 18p. (CONF-456-3)

From 18th Annual Symposium on Fundamental Cancer Research and Cellular Radiation Biology, Houston, Tex., Mar. 1964..

The disassembly of mitotic organelles, namely, those that normally have transitory existence in definite parts of the cell cycle, by subcellular microbeams is reviewed and discussed. The organelles in question belong to only three classes: chromosomes; nucleoli; and spindles and phragmoplasts. Most of the relevant investigations have been performed with uv microbeams, the beam cross sections ranging from 2 to 8 μ in diameter. (P.C.H.)

Radiation Effects Therapy and Countermeasures

Refer also to abstract 10838.

10897 (SGAE-BL-7/1964) UBER DIE STRAHLENSCHUTZWIRKUNG PSYCHOTROPER PHARMAKA (MIT EINEM BEITRAG ZU IHREM WIRKUNGS-MECHANISMUS).

(Radioprotective Effects of Psychotropic Drugs (With a Contribution to their Action Mechanism)). A. Locker and H. Ellegast (Österreichische Studiengesellschaft für Atomenergie G.m.b.H. Institut für Biologie und Landwirtschaft, Seibersdorf; Vienna. Universitat. Physiologisches Institut; Vienna. Universitat. I. Medizinische Klinik; and Vienna. Universitat). [1964]. 24p. Dep.(mn).

The effects of four new psychotropic drugs (Valium, Taractan, Tryptizol, and Insidon) on the total metabolism, tissue respiration, and body temperature were tested in the mouse. A study was also made on the radioprotective effects against lethal irradiation of 800 R. All substances produced (after i.p. injection) a decrease of the O_2 consumption and a lowering of the body temperatures. The tissue respiration in vitro of brain, muscle, kidney, and spleen tissues was inhibited by high concentrations of the drugs. All substances, when applied 15 min. before irradiation, displayed a protective effect against a lethal irradiation of 800 R. If the irradiation occurred after Taractan injection at the time of the strongest metabolism inhibition and greatest reduction of body temperature, an increase of the survival percentage was obtained. The significance of hypometabolism and hypothermia in the total mechanism of the pharmacological radioprotection is discussed. The relation with tissue hypoxia is explained. (J.S.R.)

10898 (TID-21613) THE APPLICATION OF CLONED HAEMOPOIETIC CELLS IN RADIATION PROTECTION. Progress Report. Michael Feldman (Weizmann Inst. of Science, Rehovoth, Israel). [nd]. Contract AT(30-1)-3173. 3p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Clones of hemopoietic cells were produced in vivo within the spleens of x irradiated mice injected with bone marrow and spleen cells. Clones of immune competent cells were produced by the injection into x irradiated animals lymph node cells from animals pretreated with phyto-hemagglutinins. Clones produced in the spleens of recipient animals were found to show segregation according to cell type. The capacity of cell populations from pooled clones to protect lethally irradiated mice was tested. Only clones produced by bone marrow cells had a protective effect. Immune reactions involved are discussed. (C.H.)

10899 STUDIES ON CHEMICAL PROTECTION FROM IONIZING RADIATION. II. PROTECTIVE ACTION OF SODIUM CYSTEINE THIOSULFATE. Tadeusz Szczepkowski, Tadeusz Zebro, and Jerzy Stachura (Medical Academy, Krakow). Acta Med. Polona, 5: 235-45(1964).

A disulfide compound of cysteine, which is more labile and soluble than cysteine, was used with the object of facilitating the transfer of cysteine to other thiol groups, especially in proteins. If this compound is active in protecting against ionizing radiation, it could be concluded that the protective effect of disulfides depends mainly on the ease with which they combine with the thiol groups of proteins. Sodium cysteine thiosulfate (CTS), which was used in these experiments, may be regarded as a mixed disulfide formed from cysteine and thiosulfate, with the formula $HOOC \cdot CHNH_2 \cdot CH_2S \cdot S \cdot SO_3Na$. The essential property of CTS, considered as disulfide, is that it is an unstable compound and readily exchanges its cysteine residue with other thiol compounds. CTS should react with the thiol groups of proteins, giving rise to mixed disulfides containing the cysteine residue. To verify this assumption in vivo, CTS was labelled with ^{35}S in the position linked directly to a carbon atom ($HOOC \cdot CHNH_2 \cdot {}^{35}S \cdot S \cdot SO_3Na$). CTS administered to mice before irradiation with lethal doses (520 to 850 R) of x rays exerted a protective action, as manifested by the longer survival of the animals compared with controls. After irradiation with 700 R, 30% of the treated mice survived for 30 days, whereas all controls had died by the 7th day. The most effective protection was afforded by administration of CTS three to eight min. before irradiation. At longer intervals the protective action was diminished, disappearing entirely when the interval was extended to ½ hr before irradiation. The lethally toxic doses of CTS are five to eight times higher than doses exhibiting protective action. Employing ^{35}S as a label, the protective of CTS was found to depend on the formation of disulfide compounds with serum proteins. The compound also possesses the ability of penetrating into cells. It is suggested that the production of disulfide compounds with proteins by cysteine protects the protein molecules from the harmful effect of radiation. The disulfide linkage's disruption protects proteins from damage by ionizing radiation. The compound, which contains active SH groups, may react with radicals produced as the result of radiolysis of body fluids, and it is also conceivable that sulfur compounds lower the concentration of oxygen in the cells. These findings with CTS may throw some light on the problem of why cysteine has no protective effect. This appears to be related to the ease with which mixed disulfides are formed with proteins and to the solubility of this compound. CTS very readily produces this type of compound, and by transferring the cysteine residue to protein thiol groups, exerts protective action; CTS is very soluble. (BBB)

10900 THE RADIOPROTECTIVE EFFECT OF METHYLTHIOURACIL ON THE THYROID GLAND OF THE RAT. W. R. Greig, J. Crooks, A. G. Macgregor, and J. A. R. McIntosh (Univ. of Aberdeen, Scotland). Brit. J. Radiol., 38: 72-4(Jan. 1965).

Irradiation of the rat thyroid gland in vivo inhibited the capacity of the gland to undergo hyperplasia under the stimulus of a gastrogen. An intraperitoneal injection of an aqueous solution of 50 mg methylthiouracil before irradiation significantly reduced the degree of this inhibition. (auth)

10901 BONE-MARROW GRAFTS. Brit. Med. J., 2: 523-4(Aug. 1964).

The use of homologous and autologous marrow transplantation in humans, particularly after lethal irradiation, is discussed. When homologous marrow is used the graft will not be tolerated by the host for long unless the patient's immune reactions can be modified; matching of blood groups only slightly reduces the reaction. The usual way of overcoming this intolerance has been to give the host a nearly lethal dose of radiation before administering the graft, but more recently various cytotoxic drugs have been tried. The dose of whole-body irradiation has to be so large that for the time being the patient is an immunologic cripple. Such graft treatment has been attempted for leukemia, but this method has proved dangerous and disappointing; many patients succumbed to overwhelming sepsis before the graft could take, and even if the patient survived these initial hazards there was evidence that the leukemia returned after an interval of about three months. However, one case has recently been reported of a leukemic patient given ^{60}Co whole-body radiation followed by marrow from six close relatives. The secondary reaction appeared in about ten days and lasted eight weeks before it was controlled. Eight months later the patient's blood was completely repopulated with red cells which showed the characteristics of one of the donors, and the leukemia was in complete remission. This indicates that the recipient's hemopoietic system should be given the possibility of choosing the best donor material out of several that are antigenically closely related. Also considered is the use of bone-marrow grafting for the treatment of aplastic anemia. (TCO)

10902 CHEMOTHERAPY OF LEUKOPENIA SECONDARY TO CYTOSTATIC AND PHYSICAL THERAPY. V. Perrone, D. Zarrilli, A. Faiella, and G. Pagnotta (Istituto per lo Studio e la Cura dei Tumori, Naples). Chemotherapia, 6: 112-16(1963). (In Italian)

A new drug is described which was used either to prevent or to treat leukopenias following x-ray or chemotherapy. It is called Albema and is composed of three chemical compounds: sodium thiopropionate, benzimidazil-1-(β-pyrimidylcarbamide)-2-propionate, and sodium cobaltithiopropionate. It is said that these compounds stimulate the bone marrow, particularly in the synthesis of DNA of leukocytes. The drug was effective in preventing leukopenia in 63 patients to which it was administered simultaneously with x-ray or chemical treatment, such as nitrogen mustard. In subjects with leukopenia from x-ray or chemotherapy the drug was successful in more than 50% of the

patients in elevating peripheral counts to 5000 to 6000 per mm^3 or more. Treatment consisted of parenteral administration of one to two vials of the drug (units not specified) daily for 14 to 30 days. (BBB)

10903 EFFECT OF MINERAL ANIONS ON THE RADIOSENSITIVITY OF THE MOUSE. André Cier, Jean-Claude Maigrot, and Claude Nofre (Ventre de Recherches du Service de Santé des Armées, [Lyon] and Faculte de Medecine et Pharmacie, Lyon). Compt. Rend., 259: 3656-8(Nov. 16, 1964). (In French)

The radioprotective effect of 36 mineral anions injected parenterally in the mouse was studied. The anions studied were the sulfide, sulfite, thiosulfate, neutral sulfate, acid sulfate, persulfate, arsenite, arsenate, hypophosphite, phosphite, phosphate, iodide, iodate, periodate, bromide, bromate, nitrite, nitrate, tellurite, tellurate, selenide, selenite, selenate, chloride, chlorate, perchlorate, fluoride, hydroxide, acid carbonate, neutral carbonate, cyanide, ferrocyanide, chromate, molybdate, borate, and perborate. At medium doses of γ radiation (350 rad), the sulfur, arsenic, and phosphorus derivatives, principally those that possess a low degree of oxidation, provided some protection against radiation injury. (tr-auth)

10904 ON THE PREVENTION OF RADIOINDUCED COMPLICATIONS OF THE UPPER URINARY TRACT BY CORTISONE: CLINICAL, ANIMAL EXPERIMENTAL, AND TISSUE CULTURE STUDIES. H. Muth and C. Legerlotz (Universität, Munster, Ger.). Geburtsh. Frauenheilk., 24: 408-17(May 1964). (In German)

This report describes success in preventing hydronephrosis following irradiation through the administration of cortisone. Animal experiments and a follow-up of from 12 to 24 months in 100 patients irradiated for carcinomas of the cervix showed the effectiveness of cortisone medication. These clinical observations and investigations on tissue cultures established the lack of any detrimental influence of cortisone on cancer development, such as acceleration of growth, increased rate of metastases, or recurrence. To prevent postirradiation hydronephrosis, routine prophylactic administration of cortisone to all patients receiving radiotherapy or postoperative irradiation for cancer of the cervix is recommended. A total dose of 500 mg of prednisolone is considered adequate. The following dosage schedule is proposed: starting on the first day of radiotherapy 5 mg of prednisolone is given twice daily for 45 days, followed by 5 mg daily for 7 days, and 2.5 mg daily for the last 7 days. In addition, the prophylactic administration of Supracillin (a combination of streptomycin and penicillin) during intrauterine radium applications is recommended to prevent ascending transuterine complications and subacute infections of the urinary tract. The contraindications of this regimen are: (1) diabetes and prediabetes, (2) pulmonary and extrapulmonary tuberculosis (even after clinical cure); (3) gastric and intestinal ulcers (even after cure). (BBB)

10905 PREVENTIVE AND THERAPEUTIC USE OF ULTRAVIOLET RAYS IN AFFECTIONS CAUSED BY IONIZING IRRADIATIONS. V. D. Abdullaev (Inst. of Roentgen-Radiological and Oncological, Kiev). Gigiena i Sanit., No. 11, 39-42(Nov. 1964). (In Russian)

The preventive and therapeutic effect of large and small doses of ultraviolet light on the course of the radiation sickness in rats was studied. The results showed that the application of small doses of ultraviolet light preceding the x ray treatment alleviated the course of the radiation sickness and prolonged the life of irradiated animals as compared with controls. Large doses of ultraviolet light applied after x ray treatment aggravated the course of the radiation sickness caused by a dose of 250 R. (TCO)

10906 RADIATION INJURY AND RECOVERY IN HEMATOPOIETIC ORGANS. Fumimaro Takaku, Shinji Hirano, Seitoku Fujioka, and Kiku Nakao (Tokyo Univ.). Igaku To Seibutsugaku, 67: 261-3(Nov. 10, 1963). (In Japanese)

10907 ON BONE MARROW GRAFTING IN MAN. Alexander H. Woods (Univ. of Arizona, Tucson). J. Med. Assoc. Georgia, 53: 12-15(Jan. 1964).

Some problems encountered in human bone marrow transplantation for the treatment of lethal irradiation are considered, with emphasis on the mechanics of protection by bone marrow grafts and the immunological problems involved. Results of marrow grafting in two patients are reported. The mechanical details of marrow grafting discussed include route of administration, type of filtering required, and preservation of the graft over prolonged periods (tissue banking). (TCO)

10908 ORGANIC DISULFIDES AND RELATED SUBSTANCES. IX, SYMMETRICAL AMINOTHIOLSULFONATES AS ANTIRADIATION DRUGS. Lamar Field, Aldo Ferretti, R. R. Crenshaw, and Terence C. Owen (Vanderbilt Univ., Nashville). J. Med. Pharm. Chem., 7: 39-44 (1964).

Various symmetrical aminothiolsulfonates were investigated with respect to effects of structure on protective activity against ionizing radiation and on preparation and properties. In comparison with the thiolsulfonate obtained by oxidizing cysteamine hydrochloride, a chain of five C atoms instead of two or acylation of the amine by guanyl or acetyl likewise resulted in satisfactory preparation; protective activity ranged from none to good. Thiols or disulfides containing secondary amino groups either tended to be difficultly oxidized by hydrogen peroxide or to be over oxidized (e.g., to a sulfonic or carboxylic acid); chlorinolysis afforded a promising alternative approach for a member of this class; protective action was good. Thiols containing tertiary amino groups were oxidized smoothly to thiolsulfonates which, however, were not protective. Secondary and tertiary thiols or disulfides as well as aromatic or heterocyclic disulfides containing electron-withdrawing groups, all bearing amino moieties, gave no aminothiolsulfonates with hydrogen peroxide. Stabilities of the aminosulfonates varied markedly at pH 5.4 and upon extraction as free bases. (auth)

10909 POTENTIAL ANTIRADIATION AGENTS. PREPARATION AND POLYMERIZATION OF N-VINYL-2-THIAZOLIDINONE. C. G. Overberger, H. Ringsdorf, and B. Avchen (Polytechnic Inst. of Brooklyn). J. Org. Chem., 30: 232-4(Jan. 1965).

N-Vinyl-2-thiazolidinone (VI) was prepared both by the Cope degradation of N-(2-dimethylethylamino)-2-thiazolidinone (IV) and by dehydrohalogenation of N-(2-chloroethyl)-2-thiazolidinone (V). VI is readily polymerized by radical catalysts to a white solid which softens at about 275°. Attempts to hydrolyze the polymer to poly[N-(2-mercaptoethyl)vinylamine] proved unsuccessful. VI was copolymerized with N-vinylpyrrolidone and reactivity ratios were calculated. The Alfrey-Price equations were used to determine Q- and e-values for VI. (auth)

10910 INDUCTION OF SEX-LINKED RECESSIVE LETHALS AND VISIBLE MUTATIONS BY FEEDING X-IRRADIATED DNA TO DROSOPHILA MELANOGASTER. Om Parkash (Univ. of Vienna). Nature, 205: 312-13(Jan. 16, 1965).

The radiomimetic effects of DNA irradiation products (DNAm) were studied in Drosphila melanogaster fed on DNA irradiated with 100,000 R radiation. Males emerging from larvae fed DNAm media were tested for sex-linked lethals by Muller's technique before mating with normal females. A number of visible mutations were found in the resultant cultures, in addition to a number of flies with gross morphological abnormalities. No conspicuous visible mutations or flies with morphological abnormalities were detected in cultures produced by flies fed normal DNA. Hence, the mutagenic effect of DNAm was definitely established. Assuming a spontaneous mutation rate of 0.17%, DNAm cultures showed a 32-fold increase over the spontaneous rate, an increase corresponding to a direct exposure of the spermatozoa to about 2000 R of x ray. (H.M.G.)

10911 EFFECTS OF VARIOUS TYPES OF VITAMIN A AGAINST REPEATED γ-IRRADIATIONS IN MICE. Hiroji Nagata (National Kyoto Hospital) and Tsutomu Sugahara. Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1472-5(Mar. 1964).

Survival times of repeatedly irradiated mice fed diets

supplemented with various types of vitamin A were compared. Survival time increased according to the following order: control, synthetic vitamin A, distilled vitamin A, and extracted vitamin A. The reason for the difference is discussed. (auth)

10912 THE RADIOPROTECTING ACTION OF SEVERAL PREPARATIONS. Hideo Asakura (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 47-59(Apr. 1964). (In Japanese)

The radioprotective action (protection and restoration) of Marinamycin, Chondron, Marcobin, and Pydoxal was investigated, using the indicator of 30-day survival rate of irradiated mice. The ddD-strain, male or female mice weighing about 20 g, was used. They received whole-body irradiation of about 700–800 R, of telecobalt γ rays. In the study of Marinamycin, the survival rate of controls was 25% and those of the groups administered Marinamycin before and after irradiation were 37.5 and 34.4%, respectively. It is supposed that Marinamycin has a slight radioprotective action. In another study, massive doses of Chondron, Macrobin, and Pydoxal were used comparable to the therapeutic dose. No radioprotective effect was demonstrated by administration either before or after irradiation. In the clinical study, it was demonstrated that Marinamycin had a therapeutic effect on the leukopenia due to irradiation and/or the anticancer drugs. The side effect on liver and kidney was proved to be minimal clinically. (auth)

10913 EXPERIENCES WITH TOTAL-BODY IRRADIATION AND MARROW. (Transplantation in Man and Dog). E. D. Thomas and J. W. Ferrebee (Mary Imogene Bassett Hospital, Coopertown, N. Y.). Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 2: 429-35(1964).

Infusions of isogenic bone marrow in dogs that had received lethal doses of γ radiation caused a rapid restoration of hematopoiesis and well being. The dogs own bone marrow was stored at –80 to –190°C in glycerol or dimethylsulfoxide. A case of acute leukemia was protected against the effects of a whole-body dose of γ radiation of 800 to 1,100 Rad by a bone marrow infusion obtained from an identical twin. After an initial depression of all formed blood elements there was a slow, but satisfactory, return of white cell, platelet, and reticulocyte counts toward normal beginning about 2 weeks after irradiation and continuing until the leukemia returned. Attempts to restore bone marrow function in irradiated dogs with grafts of allogenic marrow are reported. (C.H.)

10914 ON THE POSSIBILITY OF IMMUNOTHERAPEUTIC TREATMENT OF THE EXPERIMENTAL POST-IRRADIATION SYNDROME WITH BLOOD PLASMA AND BONE MARROW OF CONVALESCENT ANIMALS. Josef Panasewicz and Zofia Gloskowska (Inst. of Hematology, Warsaw). Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 2: 437-8(1964).

Blood plasma or bone marrow from rats or mice that had survived sublethal doses of 300 to 650 R x radiation was injected into other mice or rats before or after exposure to lethal doses of 850 to 11,000 R x radiation. The blood plasma and bone marrow from irradiated animals did not offer as much protection against radiation injury as did that from unirradiated animals. Possible immune reactions to irradiated tissues are discussed briefly. (C.H.)

10915 PHYSIO-PATHOLOGY AND TREATMENT OF THE SECONDARY SYNDROME COMPLICATED BY THE GRAFTS OF ALLOGENIC HEMATOPOIETIC CELLS. G. Mathe, J.-L. Amiel, J.-L. Binet, G. Seman, and R. Tenenbaum (Hôpital Saint-Louis, Paris). Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 2: 447-52(1964). (In French)

The pathology of the secondary syndrome in irradiated mice given grafts of allogenic hematopoietic cells is discussed with emphasis on the role of immune reactions to the graft tissues. The use of fetal donors, the use of hybrid mice as donors, the effects of the method used for graft cell preservation, and the effects of lymphoid cells in graft preparations on recipient response are discussed. Treatment with aminopterin or cyclophosphamide soon after injection of hematopoietic cells had a protective effect against the secondary syndrome in mouse radiation chimeras. (C.H.)

10916 EFFECT OF LONG STANDING ISCHEMIA ON BONE MARROW (ITS PROTECTIVE ACTION AGAINST GRANULOPENIA BY X RAYS AND BENZENE, IN RABBITS). Leon Braier, Ivo Kovachevich, and Oscar Sorli (Fundacid Curie para la Lucha contra la Leucemia, Mendoza, Argentina). Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 3: 585-600(1964).

A method for isolating a portion of the bone marrow by arterial ligation is described. The method was used in studies on the effects of ischemia induced by ligation in one limb of rabbits on granulopenia induced by x radiation or benzene. Results obtained in rabbits exposed to 160 R x radiation or given leukopenia-inducing doses of benzene are compared with results when one leg was Pb shielded or following the injection of aminosulfhydryl compounds, α-glyceryl esters, or potassium cyanide. It was concluded that total arterial ligation 24 hr before exposure to 160 R x radiation provides definite protection against granulopenia. The protective effect was not observed in rabbits exposed to 500 or 1100 R. Possible reaction mechanisms involved are discussed and the response of isolated bone marrow to radioprotective compounds is described. (C.H.)

10917 MACROMOLECULAR REPAIR AND FREE RADICAL SCAVENGING IN THE PROTECTION OF BACTERIA AGAINST X-RAYS. Ivar Johansen and Paul Howard-Flanders (Yale Univ., New Haven). Radiation Res., 24: 184-200(Jan. 1965).

In this study of the chemical protection of cells against x-irradiation, a distinction is made between protection by competition for free radical intermediates and protection by repair of vital macromolecules in the cell. The sensitivity of E. coli B/r to x-irradiation under various conditions was determined from the survival of colony-forming ability when plated on nutrient agar. The kinetics of radiation protection by mercaptoethanol in the presence of various amounts of oxygen revealed its action to be twofold. Firstly, at low oxygen concentrations, mercaptoethanol reduced the sensitivity in competition with oxygen. In this 40 μM oxygen competed about equally with 10 mM mercaptoethanol. Secondly, at 100 mM, it reduced by 35% the level of the plateau of radiosensitivity at high oxygen concentrations, an effect that was not in competition with oxygen. The latter property is shared by ethanol, methanol, and nitrite and is presumably due to scavenging of free radical intermediates. Nitric oxide at 300 μM sensitized anoxic cells, but protected by up to 50% at higher concentration. Intercomparison of the effectiveness of these substances in protecting cells, with published values for their reaction rates with the aqueous free radicals, leads to the conclusion that, in normally hydrated E. coli, free radical intermediates are responsible for about half the total injuries and that under aerobic conditions they have properties comparable to those of OH radicals. In contrast, substances such as nitrate, carbon dioxide, and oxygen that are known to react with reducing species, H, or the aqueous electron did not protect the cells. The intercomparison of the actions of these several substances provides a method for determining the fraction of x-ray injury to cells due to free radical intermediates and an indication of their properties. (auth)

10918 EFFECTS OF THIOETHYLPERAZINE (TORECAN) ON RADIATION SICKNESS. E. Castellano, L. A. De Santis, and G. L. Tarolo (Ospedale di Circolo, Varese, Italy). Radiobiol. Radioter. Fis. Med., 18: 61-71(1963). (In Italian)

The radiation sickness that appears in patients undergoing radiotherapy could be classified as neurologic, cardiovascular, hematologic, or urinary as far as the organ system affected. The severity of the symptoms and the probability of their appearance are proportional to the field of irradiation, its location, the amount of energy absorbed by the different organs, and the general condition of the subject. Generally, the first symptoms appear after local doses of 500 to 700 R, but usually they are not so

serious as to indicate that treatment should be terminated. Although the interpretation of the etiopathogenic mechanism of the symptom complex is still controversial, it is possible that the various symptoms are not caused by the same mechanism or by the same sequence of factors. The importance of histamine-like substances produced by radiation in the development of radiation sickness is emphasized. From animal experiments it was concluded that ionizing radiations free some vasoactive substances such as histamine, acetylcholine, and 5-hydroxytryptamine which normally are inactive in the cells. Nausea and vomiting are the major symptoms of radiation sickness which require treatment, and the drugs used are usually those with central anti-emetic action. Such drugs selectively depress the chemoreceptor trigger zone situated at the brain stem level where the vomiting reflex originates. Chlorpromazine and promazine have given satisfactory results in connection with antihistamines and pyridoxin (vitamin B_6). A new product has been used with good results: thioethylperazine (Torecan), TEP. It directly affects the emetic center and the trigger zone. An evaluation was conducted among 76 patients, 55 being treated with telecobalt therapy and 12 with x-ray therapy. Of the 55 patients in the first group, 15 who were not treated with Torecan became sick (33%). In 15 others who were treated with Torecan, gastrointestinal disturbances disappeared after two to four days of treatment. In a third group of 20 who had prophylactic anti-emetic treatment since the beginning of ^{60}Co therapy, only two suffered slight symptoms. The fourth group of patients under x-ray therapy showed radiation sickness that was curable within five days. The drug treatment consisted of one tablet of 6.5 mg of TEP once or twice a day for five or six days. The results were prompt and effective in preventing and treating radiation sickness. The drug itself did not cause side-effects even when higher doses were used. It is concluded, therefore, that the prophylactic treatment is most advantageous, and prevents, or reduces the disturbances to a minimum in ~10% of the subjects. (BBB)

10919 PROTECTION OF IRRADIATED ANIMALS BY ALLOGENIC BONE MARROW ACCORDING TO THE NUMBER OF CELLS. J. L. Amiel, R. Tenenbaum, A. M. Mery, M. Matsukura, and G. Mathe (Hôpital Saint-Louis, Paris and Institut Gustave-Roussy, Villejuif, Seine, France). Rev. Franc. Etudes Clin. Biol., 7: 970-3(1962). (In French)

The optimal number of allogenic marrow cells which can be transfused for the restoration of a lethally irradiated recipient was studied. Three-month-old male mice (AkR X C3H) were x irradiated with 950 R. Twenty-four hr later they were divided into five groups and transfused with various amounts of healthy bone marrow cells from C57B16 donors. Results indicated that optimal results were not obtained with the maximal number of transfused cells. The animals surviving the secondary syndrome in appreciable numbers were in those groups receiving 10^7 allogenic marrow cells or less. But the groups receiving less than 2×10^7 marrow cells had a large mortality rate due to defective myeloid restoration. Therefore, if immediate myeloid restoration is wanted, the optimal number of transfused marrow cells is 2×10^7 (for a mouse weighing 20 g). If a maximum number of long-term survivors is desired, the optimal cell number is between 10^7 and 10^6 cells. (TCO)

10920 ON THE EFFECT OF RADIOPROTECTIVE AGENTS ON CHICKEN EMBRYO CELLS. Fulvio Benigni, Luciana Cieri, and Maria Luisa Stein (Universita, Rome and Consiglio Nazionale delle Ricerche, Rome). Ric. Sci., Rend., Sez. B (2), 4: 697-702(June 1964). (In Italian)

The action of some known radioprotective agents and some new substances was studied on suspensions of chick embryo cells submitted to x radiations. The activity of the substances was shown by their ability to reintegrate the respiratory quotient of the treated cells to the normal value which, irradiated in the absence of the radioprotective agents, showed this value reduced to one half. (auth)

10921 IN-VIVO POTENTIATION OF THE RADIATION EFFECTS WITH 5-IODODEOXYURODINE. Frank R. Hendrickson. 7p. (CONF-556-14)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Studies were made on the in vivo potentiation effects of 5-iododeoxyuridine on radiation effects on myeloma and breast tumors in mice. Mice with myeloma that were sensitized by 5-IUDR and subsequently irradiated showed that there was significant potentiation of radiation effect from the IUDR at 300, 500, and 1000 R dosage levels. Inhibitory effects on tumor growth were demonstrated even with 100 R. IUDR plus 500 R gave a tumor response curve similar to 1500 R along. Similar results were found in mice with breast tumors. It was concluded that any cell system that is rapidly dividing will be potentiated by 5-IUDR. (P.C.H.)

10922 RADIOPROTECTIVE EFFECTS OF CYCLOBYTANE [CYCLOBUTANE] DERIVATIVES IN MICE. V. Plzak. 13p. (CONF-556-8)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

The ability of a variety of cyclobutane derivatives to protect mice against the lethal effects of whole-body x irradiation was investigated. Several of the derivatives, such as trans-2-cyano-cyclobutane carboxamide, ST-16, cyclobutane-1,2-bis(methylammonium) distearate, ST-9, and dimethyl-1,2-cyclobutane dicarboxylate, ST-7, exhibited protective effects comparable to those of some of the better radioprotective drugs. Measurements of the effect of the cyclobutane derivatives on whole-body oxygen consumption, splenic oxygen tension, and the influence of hyperoxia and hypoxia on their protective activity suggests that they act through chemical rather than physiological mechanisms. (P.C.H.)

Radiation Hazards and Protection

10923 THE RADIATION EXPOSURE OF VARIOUS STAFF GROUPS AT THE CANCER INSTITUTE, MELBOURNE, DURING THE YEAR 1959-1960. K. H. Clarke and Carmyl Winkler (Cancer Inst., Melbourne). J. Coll. Radiologists Australasia, 4: 125-8(1960).

The high degree of radiation protection for all sections of the staff at the Institute is demonstrated in the accompanying tables. Tables present the occupational radiation exposure for the various staff groups, the distribution of γ-emitting radioactive substances handled by each section during the year; and the exposure in mrem/mC of γ-emitting substances for the staff groups. The latter data are considered particularly relevant because they can be used to compare the efficiency of procedures within each group. To provide maximum protection to ward staff an upper limit of 200 mC (initial) of γ-emitting substances per ward at any one time was imposed. For patients requiring particularly heavy nursing, alternative methods of treatment to that employing large quantities of radioactive material are considered in order to reduce the radiation exposure of staff. (TCO)

10924 COMMON CAUSES OF EXCESSIVE PATIENT EXPOSURE IN DIAGNOSTIC RADIOLOGY. Hanson Blatz (Dept. of Health, New York). New Engl. J. Med., 271: 1184-8(Dec. 3, 1964).

On the basis of the results of the inspection of about 10,000 medical x-ray units and 7,000 dental installations in New York City, a list is provided of the important dose-reducing corrections that could be put into effect immediately with little inconvenience and at little cost. If this were to be done today, the average dose to patients could be reduced, it is estimated, by at least 50% immediately in most installations and by 75% or more within a month or so. Although the corrections are simple and effective, they are usually not carried out. Registration and inspection records in New York City show that about 85% of the x-ray equipment in use is owned by physicians who have no formal training in radiology. Basic improvements that could reduce the population exposure are discussed. The major portion of the genetically significant radiation that origi-

nates from medical sources is probably from fluoroscopic examinations. One fluoroscopic examination of the chest may be the equivalent of over a hundred chest films. Fluoroscopy should not be utilized routinely. Another important cause of the unnecessarily high exposure of patients during x-ray examinations is failure to use the optimum technic (kilovoltage, filtration, and distance) in routine radiography. In many x-ray installations the kilovoltage at which the equipment is operating is not known by the operator. A major source of excessive exposure to patients in radiography is the failure to limit the x-ray beam to the part of the patient's body of clinical interest. Ideally, no part of the beam should strike a patient unless it eventually passes through his body and then exposes the film. Any x rays that do not reach the film are wasted rays and merely serve to expose the patient unnecessarily. Another common but important cause of excessive patient exposure during radiography results from failure to use available dose-reducing materials. The fastest available x-ray films should be used. On the average, by more discriminating selection of film type, the exposure of most patients can be reduced by as much as 50% without interfering with the diagnostic value of the film. Another dose-reducing device is a pair of intensifying screens in a film cassette. Fluoroscopy, which should be employed only when there is a clear indication that it is preferable to radiography, should be done in absolute darkness, with equipment meeting modern standards, by a person whose eyes have been adequately dark adapted, and conducted in the shortest possible time, employing the smallest possible fields. It is concluded that most radiologists have made a conscientious effort to reduce the dose to patients being examined by x rays. Although they are well aware of the problems, most nonradiologists are ignorant of the many factors that contribute to patient dose and means for controlling it. Thus, years of attempted professional education have been unsuccessful and many states have now found it necessary to write radiation codes and institute inspection programs to see that they are carried out. (BBB)

10925 THE GENETICALLY SIGNIFICANT DOSE BY THE X-RAY DIAGNOSTIC EXAMINATIONS IN JAPAN. Tadashi Miyakawa, et al. (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 21: 565-616(Sept. 25, 1961).

A sample survey was made of diagnostic x-ray exposure in Japan. Dosimetry measurements were made of the radiation to gonads in phantoms and the human body, and the genetically significant radiation dose was evaluated. The frequencies of x-ray diagnostic examinations were classified by sex, age, and type of examination. As the result of this survey in selected districts, the genetically significant dose for the whole country could not be obtained by simple extrapolation of data, but it was possible to calculate the genetically significant dose in each district and devise a possible method for the estimation of the genetically significant dose in Japan. A second survey was of x-ray diagnostic examinations performed by hospitals and general practitioners selected at random. Calculations determined 38.6 mrem to be the genetically significant dose from x-ray diagnostic examinations. The important contribution of fetal exposure is excluded from this value. Calculations for selected districts gave the lowest values of 25.0 mrem for Nagasaki and the highest value of 77.8 mrem for Hiroshima. The annual number of x-ray examinations in Japan is between 30,000,000 and 38,000,000. It the contribution of fluoroscopy is considered, these figures are fairly good agreement with estimate from the film production. (BBB)

10926 A NEW RADIOLOGIC PROTECTION GADGET USED IN X-RAY CHEST EXAMINATION. Jan Moscicki. Polski Przeglad Radiol. i Med. Nuklearnej, 28: 619-20 (Nov.-Dec. 1964). (In Polish)

A simple device consisting of a lead-rubber plate was designed for protecting the head and lower part of the body, particularly the gonads, during chest radiography. (H.M.G.)

10927 GENETIC VARIATION AND MAXIMUM PERMISSIBLE LEVEL OF RADIATION. F. H. Sobels (Rijksuniversitet, Leiden). Proc. Intern. Congr. Human Genet., 2nd, Rome, 1240-50(1961).

Recent observations pertinent to the assessment of genetic radiation hazards are reviewed, and an evaluation was made, in the light of these observations, of whether an upper limit of 5 Rem to the population at large, excluding medical exposures, is still acceptable. Attempts were made to assess to what extent chromosome aberrations, if induced in gonial cells, will be passed to viable gametes. The dearth of experimental data, and the fact also that the induction of chromosome anomalies can be expected mainly from stages of gametogenesis with a relatively short life span, make quantitative estimates on their total increase by exposure of the population at large to low chronic doses of radiation very difficult. If it is considered that the majority of all radiation-produced mutations are deleterious in either heterozygous or homozygous condition and that there is no threshold dose or dose rate, the permissible dose levels should be reduced. (TCO)

Radiotherapy and Radiodiagnosis

10928 (BNL-8664) DOSE CALCULATIONS FOR INTRACRANIAL IRRADIATION WITH THERMAL NEUTRONS. J. S. Robertson, D. A. Levine, and L. E. Farr (Brookhaven National Lab., Upton, N. Y. and Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst.). [1964]. Contract AT-30-2-GEN-16. 14p. (CONF-640502-1). Dep. (mn); $1.00(cy), 1(mn) OTS.

From Biomathematics Symposium, Houston, Tex.

In neutron capture therapy used in the treatment of brain tumors, the intracranial contents may be regarded as being subjected to radiation from protons and gamma rays from reactions between thermal neutrons and normal tissue constituents, heavy particles and gamma rays from reactions between thermal neutrons and the neutron capture nuclide introduced, and fast neutrons and gamma ray contaminants of the incident neutron beam. A method is described for obtaining by numerical integration a modified geometry factor that takes into account build-up and non-uniform source distribution patterns for use in calculating radiation doses for thermal neutrons. (auth)

10929 (NYO-1242-1) EXTERNAL LOCALIZATION OF BRAIN-TUMORS EMPLOYING POSITRON-EMITTING ISOTOPES. Final Report. (Massachusetts. General Hospital. Neurosurgical Service, Boston and Massachusetts. General Hospital. Physics Research Lab., Boston). 1964. Contract AT(30-1)-1242. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The development of a technique for the detection and localization of brain tumors using positron-emitting radioisotopes is reviewed. The experimental work included a wide range of physical, chemical, biological, and medical investigations, as well as the design and construction of a positron scanner and a camera-type scanner for the localization of brain lesions, the evaluation of suitable isotopes for scanning, the development of computer techniques to evaluate the effects of various parameters, and the clinical evaluation of the technique. Some 6,000 patients were scanned and medical records of these patients were abstracted and coded on IBM cards. In addition to an evaluation of suitable isotopes, methods were developed for the economical production of the isotopes, chemical separation of the isotopes from the target material, and incorporation of the isotopes into suitable compounds for use in tracer studies. The principal isotopes studied included ^{74}As, ^{68}Ga, ^{89}Zr, ^{86}Rb, ^{18}F, ^{64}Zn, and ^{124}I. Scanning statistics are included for patients with confirmed or suspected brain tumors or non-neoplastic diseases scanned after the administration of tracer doses of ^{74}As or ^{64}Cu, and results using ^{124}I-gamma globulin as a tracer are discussed. A list is included of 33 publications that discuss various aspects of the work. (C.H.)

10930 (JPRS-27527) MEASUREMENT AND COMPUTATION OF ABSORBED DOSES IN EXTERNAL IRRADIATION. A. N. Krongauz, V. A. Petrov, G. A. Linchevskaya,

and N. M. Palladieva (Palladiyeva). Translation of p.3; 4-34 from "Izmerenie i Raschet Pogloshchennykh Doz Pri Vneshnem i Vnutrennem Obluchenii," Moscow, 1963. 48p. (TT-64-51776). $2.00(OTS).

Methods of measuring x and γ radiation doses used in practical radiotherapy are discussed. Formulae and tables for computing absorbed and integral doses in the diagnostic and therapeutic use of Au, Na, I, and P radioisotopes are presented. Aspects of dosimetry specifically considered are: choice of dosimetric instrument, demands upon it, and possible measurement mistakes; a method for determining absorbed dose and integral dose in distant radiotherapy with the GUT-Co-400 machine; and computation of absorbed dose in the application method of radiotherapy, in intracavity and interstitial use of closed radioactive preparations, and in open radioactive preparations. (H.M.G.)

10931 (JPRS-27762) BIOLOGICAL CONTROL OF SOME RADIOACTIVE ISOTOPES FOR MEDICAL PURPOSES PRODUCED IN THE "BORIS KIDRIC" INSTITUTE. Vera Jovanovic and Rade Draskovic. Translated from Tehnika (Belgrade), [19]: 1781-6(Oct. 1964). 12p. (TT-64-51898). $1.00(OTS).

The general problem of biologic control of radioactive isotopes used for diagnosis and therapy in human medicine is discussed. Methods of control of sterility, pyrogenicity, safety, tissue affinity, distribution, and excretion from the body of those radioactive isotopes which are used in medicine are described. Detailed description of methods and results of controls of this type are given for ^{198}Au, ^{131}I, ^{32}P, and ^{51}Cr. (auth)

10932 HISTOCHEMICAL EXAMINATION OF CERVICAL CARCINOMA DURING RADIOTHERAPY. F. Toth, S. Csomor, and G. Szlepka (Univ. Medical School, Budapest). Acta Morphol. Acad. Sci. Hung., 12: 453-9(1964).

Cancer of the uterine cervix of 23 patients who were receiving x ray and radium therapy was studied by biopsy before the beginning of treatment, after the administration of 2000 to 3000 R x radiation, after 1800 to 2000 mg/hr of radium irradiation and a further dose of 4000 R x radiation, after an additional dose of 6000 R, and after a further dose of 8000 R and 1800 to 2000 mg/hr of radium. The alkaline phosphatase reaction of adenocarcinoma cells appeared to be the most sensitive indicator of radiation. Activity did not essentially decrease at the beginning of radiotherapy, but became markedly decreased after 4000 R and 1800 to 2000 mg/hr of radium. The reaction was usually negative after 6000 R, and invariably negative after 8000 R and another 1800 to 2000 mg/hr dose of radium. Some of the granules in the tumor cells affected by radiation continued to give a positive PAS reaction. Part of them proved to be glycogen, while the rest was found to be composed of neutral mucopolysaccharides. The granulation tissue between the disintegrating parts of the tumor and its surroundings, contained dilated lymphatics and veins. Their walls were thickened by a homogeneous substance which stained red with eosin. This substance consisted partly of glycogen which gave a positive PAS reaction only before digestion with diastase, and partly of neutral mucopolysaccharides which stained red with PAS even after digestion with diastase. PAS positivity in the cytoplasm of the vacuolated tumor cells was considerably diminished, and the vacuoles themselves gave no PAS reaction. The cytoplasm and the nucleolus of intact tumor cells contained much RNA, while vacuolated cells displayed no pyroninophilia. On the other hand, giant tumor cells were seen, the cytoplasm of which contained many pyroninophilic granules. Though disintegrating under the effect of irradiation, the cytoplasm was pyroninophilic. The amount of DNA contained in the nucleus of tumor cells increased considerably under the effect of irradiation. There was a conspicuous difference in the Feulgen reaction between tumor cells and the surrounding stroma cells. (BBB)

10933 INDICATIONS AND CLINICAL EXPERIENCES WITH IRRADIATION USING FAST ELECTRONS WITH ENERGY UP TO 15 Mev. Franz Heinzler and Matthias Hohn (Institut und Klinik für Medizinische Strahlenkunde, Medizinische Akademie, Dusseldorf). Aerztl. Forsch., 17: 126-40(Mar. 10, 1963). (In German)

Treatment with fast electrons is only an extension of the use of conventional x rays, but the uniform distribution of the dose, the sharply limited field, and the critical dose falloff is superior. It permits treatment of soft tissue tumors at depths of up to 5.5 cm. Doses of more than 4000 R may produce exudative reactions, and fibrosis and induration may result from irradiation with more than 6000 R. With normal radiosensitivity, fractionation at 200 R per field for an average total focal dose of 3000 to 4600 R is optimal. Sometimes a single dose of 1000 R is permissible, but with carcinomas 5000 R is very seldom exceeded. From 8000 to 10000 R is administered to melanomas and their metastases, to cause skin induration and formation of sclerotic areas, preventing metastases. Facial carcinomas are treated with a focal dose of 3400 to 4200 R in fractionated doses of 200 R. Malignant lymphomas, lymphosarcomas, reticulosarcomas, follicular sarcomas, and lymphogranulomatoses are treated with 200 R daily, with a total focal dose of 3000 R. Sometimes 2400 R is enough to destroy lymph node metastases. Optimally, intraoral tumors receive 4000 R. Jaw tumors are difficult to treat, possibly because of the presence of bone and teeth, and a second series of irradiations can be given 8 weeks after the first series. Parotid tumors should be given 4000 to 5000 R. Laryngeal tumors are given 4000 R in either one or two fields. At the same time the lymphatic drainage area is given 2800 to 3200 R. An average of 4600 to 5000 R is given for thyroid carcinoma. Postoperatively, 3600 to 4000 R is given, but this value should not be exceeded to avoid edema. After removal of mammary carcinomas five fields are irradiated. For the first series 3000 R is given to each field, and 8 or 10 weeks later each field is irradiated with 2400 R. Usually recurrences are given 4000 to 4600 R. Radiation doses for a wide series of other tumors are included. (BBB)

10934 THE RADIOISOTOPE LABORATORY IN CLINICAL GASTROENTEROLOGY. Malcolm P. Tyor (Duke Univ., Durham, N. C.). Am. J. Digest. Diseases, 9: 576-84 (Aug. 1964).

A list of radioisotope tests which are used in clinical gastroenterology is provided along with other methods employed. The principal compounds used are ^{131}I-triolein for fecal lipid analysis, radiocobalt-labeled vitamin B_{12} for serum B_{12} levels, ^{131}I-polyvinylpyrrolidone and ^{51}Cr-albumin for detection of blood loss, ^{51}Cr-labeled red cells for blood volume, and ^{131}I-Rose Bengal for liver function tests. The usefulness of these radioisotope tests is dependent upon their accuracy, ease of performance, and the frequency with which such information is required. The frequent desirability of obtaining multiple tests using maneuvers such as those described have led to the use of relatively short-lived radioisotopes of ^{57}Co and ^{58}Co for vitamin B_{12}, which also emit γ radiation having considerably less energy than ^{60}Co. Quantitation of gastrointestinal protein loss by use of isotope-labeled substances is discussed. Such information may be obtained when ^{131}I is incorporated into a macromolecule like albumin and given intravenously to patients with various disorders. Most of the data have been accumulated with ^{131}I-polyvinylpyrrolidone, but because of problems with uniformity of molecular size, this material is no longer available commercially. Similar data are being obtained using human serum albumin labeled with ^{51}Cr. The methodology is similar, but accurate counting methods require homogenization of fecal collections. Other radioisotope methods require the tagging of red cells with ^{51}Cr using either the patient's cells or those of a homologous donor. As in the case of ^{51}Cr-albumin, the ^{51}Cr-tagged to red cells (which gains entry into the gastrointestinal tract after intravenous injection) is not reabsorbed. Fecal radioactivity may be compared with blood radioactivity and the average daily loss of red cells quantitated. Recently developed tests employing radioisotopes are outlined, with a discussion of their relative advantages and disadvantages over earlier methods. (BBB)

10935 AN X-RAY MICROSCOPE DESIGNED FOR STUDY OF LUNG PARENCHYMA. Charles Oderr and Michel Dauzat (Veterans Administration Hospital, New Orleans). Am. Rev. Respirat. Diseases, 90: 448-52 (Sept. 1964).

Applications of x-ray microscopy in the study of chemical and geometric details of lung tissue are discussed. However, difficulties arise because it is not practical to have the pertinent lung tissue elements in close contact with the photographic emulsion. The geometric structure of the lung is such that making sections thin enough for contact x-ray microscopy destroys essential architecture. To overcome this difficulty, a modification was made in the design of the Cosslett-Nixon projection-type x-ray microscope. A description of the design and uses of this specially designed instrument for lung tissue study are given. It produced soft x rays requiring high vacuum and followed a large specimen field size (35 mm dia) to be obtained. The power supply ranged from one to 12 kvp. The vacuum plant used both mechanical and diffusion pumps. A diagram of the power supply is given. The filament and electron gun design was the same as that employed in electron microscopes. The target was of the transmission type made of metal foil. The electron beam could be collimated and manipulated by an aperture system and magnetic lenses, so that a central beam of only a few μ in dia. hit the upper surface of the Al foil. Either the electron beam or the x-ray beam could be used for focusing. The x-ray beam method of focusing was limited to the highest kilovoltage (12 kvp). In this case a convenient object, such as a 500- or 1000-mesh silver grid, was placed between the transmission target and the phosphor. The camera used was large enough so that the relatively large specimen and photographic plate could be positioned within the camera chamber, but outside the beam area during focusing, and then slid into position (between the grid and the phosphor) by external manipulation when focusing had been accomplished. (BBB)

10936 DESTRUCTION OF THE HYPOPHYSIS WITH A $^{90}Sr-^{90}Y$ NEEDLE. Paul V. Harper, Nels Strandjord, Edward Paloyan, Robert D. Mosely, Nancy E. Warner, and Katherine A. Lanthrop (Argonne Cancer Research Hospital, Chicago). Ann. Surg., 160: 743-51(Oct. 1964).

A new approach to radiative destruction of the hypophysis is described, as well as its use as an adjuvant in the therapy of certain forms of malignancy and of diabetic vascular disease. The technic employed a removable applicator of ^{90}Y, in equilibrium with its long-lived (28-year half-life) parent ^{90}Sr, which gives a virtually permanent source of ^{90}Y β radiation. Such a source was constructed with a strength (54 mC) capable of producing in ~one hr destruction equivalent to a permanent implant of ^{90}Y. The radiation dosage from ^{90}Y required to produce necrosis of the anterior hypophysis is estimated at 110,000 to 190,000 Rad when the radiation is delivered over the entire decay period of ^{90}Y. When the radiation is delivered in one hr, the same degree of destruction should be obtainable with considerably less radiation dosage. To estimate the effect, the $^{90}Sr-^{90}Y$ souce was inserted into the hypophysis in four patients with advanced mammary carcinoma for periods of 15, 30, 60, and 90 min. The extent of the destruction thus produced was estimated at post-mortem examination four to six weeks later. The 90-min exposure produced necrosis up to 4.0 mm from the source, corresponding to a radiation dose of 40,000 Rad. Thus two 60- to 90-min applications 4 mm apart should produce virtually complete destruction of the gland. This procedure was carried out on 29 patients with no evidence of extraocular nerve damage. Pathologic specimens from three patients who had bilateral 90-min exposures showed destruction of the hypophysis was 90 to 100% complete. In the four with bilateral 60-min exposures, destruction was less complete, 80 to 90%. Since the source contained 54 mC of ^{90}Y, ~75 mC-hr in each side of the gland is the minimal effective dose. While the danger of nerve damage was slight, the problem of cerebrospinal fluid leakage was present; of 29 patients, four (14%) developed transient leaks. The preliminary clinical results on 19 patients with metastatic breast carcinoma showed relief of symptoms in nine, and of these, two showed marked objective regression of tumors. One patient with embryonal carcinoma of the testis has had a marked regression of pulmonary metastases. One choriocarcinoma of the testis and two metastatic melanomas showed no response. There was no operative mortality. It is concluded that the trans-sphenoidal radiative destruction of the hypophysis using a 54-mC sealed source of $^{90}Sr-^{90}Y$ is generally applicable and relatively free from complications. (BBB)

10937 RADIOACTIVE ISOTOPES FOR ADJUVANT CANCER THERAPY: ANIMAL EXPERIMENTATION AND PRELIMINARY RESULTS IN HUMAN APPLICATION. Irving M. Ariel (Pack Medical Foundation, New York). Arch. Surg., 89: 244-50(Aug. 1964).

Microspheres of ^{90}Y were tested as a means of preventing the growth of cancers after transplantations into the peripheral veins of rabbits. Also described is experience with two patients who received ^{90}Y microspheres, one of whom also received ^{90}Y N-hydroxyethylenediaminetriacetic acid (EDOL) prophylactically, after surgical resection of cancers which have a high incidence of metastasizing to the lungs, and in the latter instance, to bones. In the rabbits 4 mC of ^{90}Y radiating microspheres, with a specific activity of 1 mC/mg and suspended in 4 ml of diethylene glycol monethyl ether, was injected into the opposite ear vein from five to 15 min after the injection of the Brown-Pearce tumor epithelioma cells. The microspheres were of uniform size, measuring from 40 to 60 μ in diameter. They were inert chemically and physiologically. When introduced into an afferent artery, they lodged almost 100% in the organ supplied by the artery. Various other radioactive isotopes could be permanently bound to the ceramic microspheres. ^{90}Y is a pure β emitter with a half-life of 65 hr. In another group, mechlorethamine hydrochloride in a dose of 0.1 mg/kg of body weight was injected into the opposite ear vein five to 15 min after the injection of the tumor cells. When the ^{90}Y ceramic microspheres were injected subsequent to the injection of Brown-Pearce epithelioma intravenously in rabbits, they exerted a marked protective effect (equaling 74%) in preventing the growth of tumors in the lungs. In the control group, 24 of 25 animals had tumor growths, the average number of nodules being 15. When the ^{90}Y microspheres were given subsequent to the inoculum of Brown-Pearce rabbit epithelioma, only eight of 28 animals treated revealed tumors; in these eight, the average number of nodules was five. Mechlorethamine exerted some protection in that 19 of 25 animals revealed tumor of the lungs, the average number of nodules per animal being ten, but the ^{90}Y microspheres offered far greater protection. Two patients treated with ^{90}Y adjuvant therapy, one of whom also received ^{90}Y-EDOL, are well nine months, and one year and nine months, respectively, after treatment. There was no evidence of any harmful effect from the radioactive isotopes; however, an inherent danger of this technique is the long-term effect of radiation upon the pulmonary tissue. (BBB)

10938 TREATMENT OF EXPERIMENTAL TUMORS: UTILIZATION OF RADIOACTIVE MICROSPHERES. Robert J. Blanchard, Ivan Grotenhuis, James W. LaFave, Charles W. Frye, and John F. Perry, Jr. (Univ. of Minnesota, Minneapolis). Arch. Surg., 89: 406-10(Aug. 1964).

Experimental and clinical studies evaluating the usefulness of radioactive microspheres in treatment of tumors are reported, along with the treatment of established experimental tumors. Hepatic deposits of VX2 carcinoma were arrested or eliminated by hepatic artery injection of ^{90}Y microspheres. Peritoneal implants of the same tumor similarly regressed after application of Silastic patches containing ^{90}Y microspheres. Measurements of β irradiation using lithium fluoride phosphor in Teflon capsules in the livers of three animals gave values of 966, 1290, and 7933 Rad. In subperitoneal tumors values ranged from 10 to 6960 Rad. Yttrium-90 was utilized because it emits high-energy β irradiation and has a short half life (64 hr).

There is limited tissue penetration of the energy (50% absorption in 0.26 cm, 100% absorption in 1.03 cm); therefore, to be effective very even distribution of the isotope in the treated tissue is necessary. Results are also reported briefly on 31 patients who received β radiotherapy with microspheres for various types of malignancies. Microspheres were administered by intravascular route, by direct injection, and by patches. 31% showed objective evidence of tumor regression, 34% of tumors were not accessible for objective evaluation, and 22% of patients showed clinical improvement. Death attributable in part to microsphere administration occurred in six patients. (TCO)

10939 RADIOSENSITIVITY OF THE GUERIN ANAPLASTIC EPITHELIOMA IN RATS FOLLOWING ACUTE AND FRACTIONATED X-RAY IRRADIATION PERFORMED WITH A 200-kvp MACHINE. G. de Renzi, L. D'Ambra, and R. Salvetti (Centro Nucleare di S. Piero a Grado, Pisa, Italy). Boll. Soc. Ital. Biol. Sper., 40: 356-9(Apr. 30, 1964). (In Italian)

Thirty adult Wistar rats, divided into a control group, acute-irradiation group, and fractionated irradiation group, received Guerin T8 tumor fragment implants subcutaneously. Tumor growth occurred in 97% of the implanted animals. Irradiation localized to the primary tumor was performed with acute 6000 R x ray doses in the second group and fractionated doses (600 R every three days) in the third group. On the 12th day following the implantation the average diameter of the tumor fluctuated between a maximum of 20 to 25 mm and minimum of 16 to 21 mm with a height of about 12 mm. The tumors presented a well-palpable nodule and, upon death of the animals, a post-mortem examination was performed. The control group showed a progressive body growth curve of 24 days, with a peak reached at the 12th day. The acute irradiation group showed the following mean data: body weight at implantation 197.6 g, body wt at death with tumor and metastases 189.7 g, wt without neoplastic tissue 165.8 g, wt loss after implantation 29.8 g, volume of the primary tumor at irradiation 10.1 cm^3, tumor volume at death 14.0 cm^3, survival time after implantation 67.6 days. The tumor growth curve of this group showed a slight volumetric increase of the primary tumor on the first to third day following irradiation. From the fourth day on the volume of the principal tumor decreased significantly to remain unchanged from the 24th to the 42nd day. The tumor then resumed growth activity on this date, reaching its previous size on 52nd day followed by death of the animal after a max of 78 days. The tumor was slightly larger at this point than on onset of irradiation while notable-sized metastases were observed. The animals in this group which died due to the neoplasms showed a 30-day longer life duration in comparison to the control group. The following data were observed in the fractional irradiation group: body wt at implantation 197.2 g, body wt at irradiation 12 days after implantation 207.9 g, volume of principal tumor at death 10 cm^3, survival time 74.5 days. The tumor growth curve of this group showed slight initial volumetric increase of the principal tumor which increased until the sixth day and then decreased with a continuously more marked decrease until on the 24th day when the tumor in all animals was nearly impalpable. Four animals died on the 58th, 64th, 78th, and 98th days, respectively, due to metastases. When the surviving animals were sacrificed on the 120th day, post-mortem examination did not reveal metastases. The animals showed complete regression of the tumor, and the fibrotic tumor site was negative for tumor cells. The life duration of this group was 47 days longer than that of the control group. It appears that the fractional treatment caused complete regression while the acutely irradiated group showed only a partial regression. The tumor growth resumption was unexpected in seven animals of the acute irradiation group; their death appears to have been caused by metastases. In the animals in which the implanted tumor regressed completely, an adhering small fibrotic nodule was observed formed by compact connective tissue with no signs of neoplasm. An implantation test of this tissue performed on healthy animals was negative. (BBB)

10940 RADIOSENSITIVITY OF THE OBERLIN AND GUERIN MYELOMA OF THE RAT FOLLOWING ACUTE AND FRACTIONATED IRRADIATION WITH 60-KVP X RAYS. G. de Renzi, L. D'Ambra, and R. Salvetti (Centro Nucleare di S. Piero a Grado, Pisa, Italy). Boll. Soc. Ital. Biol. Sper., 40: 352-6(Apr. 30, 1964). (In Italian)

Thirty adult Wistar rats were divided into a control group, an acute irradiation group, and a fractionated irradiation group. The animals received subcutaneously implanted fragments (size ca. 10 mm) of T58 Guerin tumors obtained from animals with previously implanted tumors (35th implant). The average base section of the control tumors on the tenth day fluctuated between a minimum of 13 to 18 mm, maximum of 18 to 22 mm, and height of 11 mm. The tumors presented as adhering, firm, and well-palpable, nonulcerated nodules, while metastases were not observed during the entire study. The ten control animals showed the following average data: body weight at implantation 195.9 g, wt at death with tumor 175.8 g, wt loss 56.4 g, tumor volume at death 38.3 cm^3, survival time 33.7 days, body wt without tumor at death 139.5 g. For the second group, which received an acute irradiation dose of 6000 R of 60-kvp x rays, the average data were: body wt at implantation 196.8 g, wt at irradiation 205.9 g, body wt at death with tumor 179.2 g, without tumor 142.9 g, wt loss 53.9 g, tumor volume at irradiation 7.4 cm^3, vol at death 36.9 cm^3, survival time 36.9 days. After the ninth day the tumor growth volume overlapped that of the controls. Deaths in the second group began to occur the 19th day after irradiation. The third group received the same total x ray dose and intensity but fractionated at 600 R with a three-day interval between irradiations. The following average data were observed in this group: body wt at implantation 198.5 g, wt at irradiation 209.5 g, wt with tumor at death 190.1 g, without tumor 163.2 g, wt loss 35.3 g, volume of tumor at irradiation 6.9 cm^3, survival time 53.4 days. The tumor curve overlapped that of the controls for the first six days. A marked carcinolytic action, reaching its peak at about the sixth treatment, manifested itself at this time. From then on until the 27th day irradiation had a carcinostatic action, resulting in volumetric reduction of the tumor. After the 27th day the tumor size increased rapidly leading to the death of the animals. At the 20th day the tumor was ca. 35 cm^3 both in the control and the acute irradiation groups; in the fractionated group it showed a volumetric decrease followed by resumption of growth on the 30th day, reaching the volume of the other two groups on the 37th day. This fractional irradiation technique produced only temporary carcinolytic and carcinostatic results without causing complete regression of the tumor, and, in all cases, at the end of the radiologic treatment the tumor resumed its normal development leading to the death of the animals. (BBB)

10941 SCINTISCANNING IN SPACE-OCCUPYING LESIONS OF THE SKULL. R. Spencer (Liverpool Radium Inst.). Brit. J. Radiol., 38: 1-15(Jan. 1965).

The historical development of scintiscanning for brain tumors and the general theory of the technique are reviewed. The technique in 50 consecutive cases is described and the results analyzed and compared with other series. The radiation dosage is discussed. An attempt was made in general terms to link up the scan results with the pathology of the underlying space-occupying lesions. Although we understand very little concerning the biochemical and physical processes taking place, there is no doubt that this technique of scintiscanning is an extremely important contribution to the art of investigation of neurological cases. (auth)

10942 CARCINOMA OF THE THYROID FOLLOWING TREATMENT OF HYPERTHYROIDISM WITH RADIOACTIVE IODINE. Mitchell S. Karlan, William Frank Pollock, and William H. Snyder, Jr. Calif. Med., 101: 196-9(Sept. 1964).

An 11-yr-old girl was found to have a thyroid carcinoma 27 months after radioiodine therapy for a diffuse toxic thyroid gland. The initial treatment of her hyperthyroid condition consisted of an oral dose of 1.25 mC ^{131}I, which was followed six months later by an additional dose of 2.0 mC. Exploratory surgery 27 months after beginning ^{131}I

treatment revealed a prominent nodule 3-mm in diameter. Histologic examination showed a papillary carcinoma in the nodule, invading through the capsule. When last examined four years later, she showed no evidence of recurrent neoplastic disease. The patient had had numerous diagnostic x-ray studies relative to a cardiac anomaly. It is possible that these previous x-ray studies of the chest played some small part in the development of the thyroid carcinoma. However, she had a diffuse toxic goiter without clinical or scintigram evidence of neoplastic nodules until after the radioiodine therapy. It is suggested that operation is the treatment of choice in thyrotoxic patients under 20 yr of age. It is effective, entails virtually no mortality, no genetic risks, no risk of carcinogenesis, and a very low incidence of postoperative hypothyroidism or technical complications. A definite conclusion is not drawn from this case, but there is a suggestive correlation between the radioiodine therapy and the carcinoma. It is felt that additional time must elapse before this radioactive agent can be considered safe for use in children. The genesis of malignancy in radioiodine-treated patients is briefly reviewed. Both goitrogens and radioiodine have been implicated in the production of thyroid cancer in animals. A significant number of cases of leukemia also have been reported following the use of radioiodine, with a period of latency ranging from three months to several years. Although problems relative to neoplasia or genetic changes are the main points in the controversy as to whether or not to use radioiodine in young patients, there are other basic problems concerned in its use in this age group. These include reports of posttherapy hypothyroidism, the incidence ranging from 2.4 to 24%. (BBB)

10943 RADIATION THERAPY OF BENIGN CONDITIONS. William A. Thurman, Jr., and George Cooper, Jr. (Univ. of Virginia, Charlottesville). Clin. Med., 70: 21-31 (Jan. 1963).

Because of the growing understanding of radiation hazards, the place of irradiation in the therapy of benign conditions is considered. In the treatment of furuncles and carbuncles it is not clear how ionizing energy influences infection, but there is no direct bactericidal action from the small doses of irradiation which are most effective, nor an increase in antibody production by stimulation of the body's immunologic response. Of 33 patients treated for furunculosis, carbuncle, or cellulitis, in 23 the infections cleared up promptly. After irradiation for tuberculous cervical lymphadenitis, good regression of the involved lymph nodes was achieved after persistent medication had failed. Usually four to eight treatments of 100 R in air given at weekly intervals was sufficient. It is suggested that with careful selection of patients and thoughtful handling, x-ray therapy for benign conditions can be administered without significant hazard. (TCO)

10944 A NEW METHOD FOR DETERMINATION OF DIVIDED RENAL BLOOD FLOW IN MAN BY USE OF RADIOACTIVE INERT GAS. J. Ladefoged and E. Kemp (Glostrup Hospital, Copenhagen). Excerpta Med. Intern. Congr. Ser., 78: 841-3(Aug. 1963).

For study of the pathogenesis of renal hypertension a specific technique for determination of divided renal blood flow for clinical use is required. A new method for determining divided renal blood flow and intrarenal blood flow distribution in man is presented and some results from its clinical application described. The theory of the exchange of inert gas in tissue is discussed. For a radioactive gas, the emission from the gas is proportional to the total quantity of the gas and the desaturation of radioactivity (A_t) from tissue is given by: $A_t = A_0 \cdot e^{-(f/v \cdot \lambda)} \cdot t$; where A_0 is radioactivity at time t = 0, v is tissue volume, and λ is the tissue blood partition coefficient. From this formula blood flow (f) in ml/volume/min can be calculated by: $f = (0.693/T_{\frac{1}{2}}) \cdot \lambda$; where $T_{\frac{1}{2}}$ is the duration in min to half the quantity of gas in the tissue. These considerations are valid for a tissue with homogeneous blood supply, which in the kidney is not present. However, the kidney has three zones with different perfusion rates: cortex, outer medulla, and inner medulla. Blood flow in the cortex exceeds the outer medullary flow ~ten times and the latter again exceeds the inner medullary flow about ten times; therefore, it is possible by graphic analysis of the decay curves to separate the components and calculate the blood flow for each. The practical performance of the test is as follows: 1 mC ^{133}Xe (or 5 mC ^{85}Kr) dissolved in 5 ml sterile saline is injected into the renal artery which is catheterized from the femoral artery. The injection is fast, lasting about 5 sec and stops suddenly. The build-up and subsequent clearance of the gas is measured externally by a scintillation detector covered by a wide-angle collimator. The detector is connected to a linear ratemeter. The obtained curves, as a semilogarithmic plot, make it possible to separate a fast component, the cortical flow, and two slow components, the medullary flows. In normotensive patients without renal disorders, renal cortical blood flow varied from 3.5 to 4.4 ml/g/min, in agreement with accepted figures for normal renal blood flow. The flow in the outer medulla varied from 0.3 to 0.6 ml/g/min and the flow in inner medulla from 0.01 to 0.05 ml/g/min. Results from hypertensive patients with various renal disorders are also shown. The results suggest that the model is valid in determinations of renal blood flow and that hypertensive patients show reduced values for cortical blood flow. (BBB)

10945 ACUTE RADIATION PERICARDITIS. R. I. Portioli and G. Botti (Università, Parma, Italy). Folia Cardiol., 22: 257-65(May-June 1963). (In Italian)

A left total mastectomy was performed on a 37-yr-old woman with a mammary neoplasia, and a month later she started to receive radiotherapy (200-R doses of 180-kv x rays) in the left anterior thoracic region. After the seventh session the patient complained of an oppressive, moderate pain in the precordial region, which was intensified by respiratory movements and coughing. In spite of these symptoms, she was subjected two days later to another session of irradiation. The next day she had an episode of tachycardia accompanied by collapse and fever. The patient was admitted to the hospital with clinical, radiological, and hematological findings typical of acute pericarditis. These symptoms lasted for 8 days, the pericarditis being diagnosed as caused by irradiation. The patient was treated with a radioprotective drug, β-mercaptoethylamine, and cortisone, and within two weeks was free of symptoms. The short period of time between the irradiation and the onset of symptoms, the lack of data suggestive of a different etiology, and the rapid response to the therapy established that the pericarditis was due to the irradiation. The demonstration of acute radiation pericarditis as a clinical entity is interesting as regards the study of the secondary effects of the radiotherapy, and this case illustrates the importance of the differential diagnosis of myocardial infarction from cardiac radiation injury. (BBB)

10946 INTERSTITIAL HEMANGIOMA IRRADIATION WITH RADIOACTIVE ^{32}P-COLLAFIL-THREADS. H. Teller (Stadtischen Krankenhauses, Berlin). Hautarzt, 13: 34-6 (Jan. 1962). (In German)

Eight children, ranging in age from 5 to 24 months, with various types of hemangiomas located in various regions of the head, neck, sternum, and gonads were treated by the method of ^{32}P interstitial irradiation. Depending on the size of the hemangioma treated, the length of thread used varied from 6 to 25 cm. However, the ^{32}P activity used in all cases was 0.1 mC/cm. Regression of the hemangiomas began within 3 to 4 weeks after insertion of the radioactive threads. Usually a cordlike induration appeared at the site of implantation. Generally, this disappeared slowly, but spontaneously. The hemangiomas were healed over periods that ranged from 11 to 18 months after the threads were implanted. (TCO)

10947 RADIOISOTOPE RENOGRAM IN KIDNEY TRANSPLANTS. Merle K. Loken, Edward V. Staab, Robert L. Vernier, and William D. Kelly (Univ. of Minnesota Hospitals, Minneapolis). J. Nucl. Med., 5: 807-10(Oct. 1964).

The use of ^{131}I-Hippuran for the preparation of renograms to follow the clinical course of patients after renal transplants is described. Abnormal patterns were obtained at various times following the transplants. Delayed excretory phase with a gradual depression of the functional peak was

the most consistent pattern seen during a rejection reaction. The interpretation of the renogram pattern did not always correlate with the clinical status. In some cases an abnormal pattern persisted despite an improvement in urine output and blood chemistries. Continued investigation in man and animals as to the value of the renogram in kidney transplants is being carried out. (auth)

10948 STATISTICAL EVALUATION OF 125-I VS 131-I FOR SCANNING COLD LESIONS. Raymond L. Libby (Univ. of California, Los Angeles). J. Nucl. Med., 5: 886-94(Dec. 1964).

A statistical analysis of the relative delineation potentials of ^{125}I and ^{131}I for scanning a cold 3-cm-diameter lesion indicates that ^{125}I is better than ^{131}I, not only for a surface lesion, but also for lesions located as much as 2 cm below the surface. For a cold 3-cm-diameter lesion located at depths of 3 cm or greater, neither ^{125}I nor ^{131}I would delineate such a lesion under the specific conditions chosen for this study. The application of the type of measurements made in this report and their statistical analysis is discussed in relation to the probability of detecting a lesion by ordinary scan techniques. (auth)

10949 A RAPID DETERMINATION OF THE SPECIFIC ACTIVITY OF 85-KRYPTON IN PRESSURIZED CYLINDERS. Kenneth D. Williams (National Inst. of Health, Bethesda, Md.). J. Nucl. Med., 5: 913-19(Dec. 1964).

During the past several years, the inhalation of radioactive ^{85}Kr gas has been utilized as a diagnostic method in the identification of left-to-right circulatory shunts. The current procedure requires the patient to breathe a mixture of ^{85}Kr in air directly from a pressurized cylinder. To estimate the radiation exposure to the patient, it is necessary to know the concentration of the inhaled ^{85}Kr mixture prior to administration. A precise value for the specific activity of ^{85}Kr in a given cylinder may be obtained by removing a sample of gas and comparing it with a certified ^{85}Kr gas standard at a known temperature and pressure. This procedure is time consuming when dealing with a large number of cylinders. A simple, sensitive, and rapid method is described that was devised to eliminate the need for sampling the gas from all the cylinders. The method uses external counting of the cylinder and a simple calculation based on cylinder volume. (C.H.)

10950 INTERNAL DOSIMETRY STUDIES OF RADIOPHARMACEUTICALS. I. TOLPOVIDONE ^{131}I. Jonathan P. Miller*, Ann Dalziel, and L. E. Michael Crawford (*Abbott Labs., Chicago and Abbott Labs., Oak Ridge, Tenn.). J. Nucl. Med., 5: 926-35(Dec. 1964).

The distribution and effective half-life of Tolpovidone ^{131}I (^{131} Raovin) was studied in both rats and cats. These data have been extrapolated to man to estimate the radiation dose delivered during the use of ^{131}Raovin for brain scanning and diagnosis of hypoalbuminemia. Radiation dosage calculations indicate that a 30 μc dose of Tolpovidone ^{131}I delivers considerably less radiation than maximum permissible quarterly occupational exposure limits and that a 500 μc dose of Tolpovidone ^{131}I delivers less radiation than established yearly exposure limits. (auth)

10951 CLINICAL VALUE OF GENERATOR PRODUCED 87-M STRONTIUM. R. L. Meckelenburg. J. Nucl. Med., 5: 951-7(Dec. 1964).

The usefulness of the yttrium–strontium generator for making a short-lived isotope available to laboratories remote from the production facility is discussed. The present technique demonstrates the simplicity of the process required for the use of ^{87m}strontium in patients. The low radiation exposure makes this particular isotope suitable for study of nonmalignant conditions, such as fractures, infections, and osteopenic states. Even studies in children can be performed without undue exposure. Because of the short half-life, repeat studies of bone metastasis can be made to measure the effectiveness of different forms of therapy. The large doses possible with ^{87m}Strontium improve counting statistics and thereby enhance resolution, gaining better definition and shorter scanning times. (auth)

10952 CARCINOMA OF THE ESOPHAGUS TREATED BY COMBINED RADIATION AND SURGERY. Isam N. Anabtawi, Edwin L. Brackney, and Robert G. Ellison (Medical Coll. of Georgia, Augusta). J. Thoracic Cardiovasc. Surg., 48: 205-10(Aug. 1964).

The advantages of combining ^{60}Co irradiation with surgical excision of esophageal cancer are cited with reference to 63 patients undergoing the combined treatment. Patients who had no obvious evidence of metastasis received supervoltage radiation as a 6000-Rad tumor dose over a period of six weeks. During this interval, the nutritional state of the patient was improved, but despite supplementary feedings by the oral or gastrostomy route most of these patients failed to gain weight. After completion of the radiotherapy, the patients underwent a first-stage procedure consisting of retrosternal interposition of the right hemicolon. Survivors of the first procedure underwent a second-stage procedure which consisted of total esophagectomy through the right chest two to three weeks later (four to six weeks after completion of radiation therapy). In only about 10% of the patients was supervoltage radiation effective in eradicating all gross and microscopic evidence of the neoplasm. The remaining patients had residual tumor in the esophagus or evidence of regional metastasis. Thus, the results of surgical treatment and palliative radiation were poor; despite this, it is suggested that palliative therapy is justifiable. Restoration of swallowing, restoration of nutrition, and prolongation of life were the worthwhile benefits. The outlined program combining supervoltage radiation with surgery appeared to offer some advantages. Radiation with high-voltage or telecobalt units at a tumor dose of 6000 Rad caused marked regression of the tumor, destruction of small lymphatic foci and, in some cases, complete eradication of gross and microscopic evidence of neoplasm. Total esophagectomy is the only way to cope with the anatomical and pathological peculiarities of this neoplasm. This would insure against local recurrence in the unexcised esophagus and a more complete eradication in the lymphatics. Pre-operative radiation therapy did not make total esophagectomy technically more difficult. On the contrary, the tumor was usually smaller and the periesophageal fibrosis slight, provided surgical resection was performed within 6 weeks after completion of therapy. (BBB)

10953 RADIOBIOLOGICAL BASIS OF RADIATION THERAPY IN THE TREATMENT OF CANCER. Peter Zanca (Robert B. Green Memorial Hospital, San Antonio). Med. Times, 92: 900-7(Sept. 1964).

Various aspects of radiosensitivity of normal and cancer cells are discussed, especially with reference to principles of radiotherapy. Factors influencing radiosensitivity and biological response considered are: the biological and physical state of tissue, the time-dose relation of irradiation delivered, and the condition of the tumor bed. Types of radiation injuries resulting from therapy of various tissues and organs are pointed out, and variations in radiosensitivity are indicated. (TCO)

10954 HEPATOPROTECTIVE THERAPY DURING GYNECOLOGIC ANTITUMOR TREATMENT. A. Misto (Università, Milan). Minerva Med., 54: 1964-9(July 4, 1963). (In Italian)

Changes in the liver functions were observed in patients with tumors of the genital system during radium and ^{60}Co therapy at total doses of 5000 R given over 20 to 30 days. Changes were noted in glycemia, the number of circulating leukocytes, coagulation time, and bilirubinemia. Also observed was the formation of radionecrohormones and other toxic products in the irradiated area. The radioinduced breakdown of H_2O in the tissues also occurs with formation of free radicals which in the presence of O_2 form H_2O_2, irterfering with enzymatic reactions. Therapy with cytostatic compounds affects the cellular metabolism of liver causing direct damage to the cytoplasm and the appearance of icterus. Prevention of these changes in liver was attempted by treatment of patients undergoing radiotherapy with a new preparation called Citruplexina. It contained a so-called antitoxic liver factor plus ornithine, citrulline,

and arginine. Tests of liver function (blood bilirubin level, Ucko, Takata-Ara, and Wunderly-Wuhrmann tests; glutamic-oxaloacetic and -pyruvic transaminases; and the Quick test for prothrombin levels) were performed before and after treatment with the liver protective drug in 18 patients aged from 21 to 72 (one phial was given intramuscularly daily for 12 days) while other radiotherapeutic subjects acted as controls. Due to the different ages of the patients observed, the therapeutic action of the preparation was not uniform but an improvement was generally noted in the serum colloidal lability tests, bilirubinemia, and prothrombin time. The results were generally considered to be favorable as regards the blood-clotting factors. (BBB)

10955 RADIATION DIAGNOSIS, RADIATION HEALTH SCIENCE, AND RADIATION PROTECTION. FIRST HALF YEAR, 1963. Friedrich Ekert. Muench. Med. Wochschr., 106: 85-94(Jan. 10, 1964). (In German)

Important progress in x ray and radiation diagnosis using the image intensifier, television cinematography, x ray television, the image retention oscilloscope, is reported. Applications in phlebography, transseptal laevography, cholecystography, aortography, angiography, lymphography, and coronarography are reported. New x-ray procedures for diagnosis of tumors of various internal structures and organs, such as the mediastinum, bronchi, lungs, stomach, and kidneys, are described. Skeletal changes observed in the spinal column, ileosacral joint, scapula, and skull are described. Radioisotopic diagnosis and therapy with ^{60}Co, ^{131}I, and ^{198}Au are outlined. Results of radiotherapy of melanomas, osteosarcomas, uterine carcinoma, and carcinoma of the lip are reported. Problems of radiation protection encountered during treatment for several types of x-ray and telecobalt procedures are discussed. (BBB)

10956 PROBLEM OF HYPOTHYROIDISM AFTER ^{131}I THERAPY OF HYPERTHYROIDISM. John B. Stanbury and Leslie J. DeGroot (Massachusetts General Hospital, Boston). New Engl. J. Med., 271: 195-6(July 23, 1964).

Hazards associated with the use of ^{131}I in the treatment of Graves' disease are reviewed. The initial concern for the dangers of ^{131}I have not in general been supported by experience, and arbitrary age barriers to its use have gradually fallen so that now most clinics use it freely in patients beyond the 25th year. Only two possibly malignant tumors have been reported in patients previously treated with ^{131}I, and both were in adolescents. Since between 100,000 and 200,000 persons have now been treated with ^{131}I, since the annual incidence of thyroid cancer is ~25 per 1,000,000, and since physicians have been looking for this complication, it might be expected that tumors would by now be reported in significant numbers if ^{131}I is an important carcinogen. So it can be concluded that ^{131}I has not displayed any noteworthy carcinogenic capacity. The real hazard of ^{131}I therapy appears, unexpectedly, to be hypothyroidism, initially accepted as a minor and easily remediable complication. It is found in 8 to 12% of patients within the first year or two of treatment. Thereafter there is an annual increment of ~3% per year, and by seven years the incidence may reach 25%, and there is no sign of any diminution of the annual increment of new cases. Thus, nearly one out of every three persons who has received ^{131}I is destined to become hypothyroid. Thus ^{131}I then not only causes early damage to the gland but also induces subtle changes that may have consequences not clinically evident for many years. Possible ways in which such latent injury may be produced are discussed, as well as means for preventing it. (TCO)

10957 FUNDAMENTAL STUDIES ON THE DIAGNOSIS OF MALIGNANT RUMORS USING ^{32}P BREMSSTRAHLUNG. (THE RADIOISOTOPE DIAGNOSIS OF MALIGNANT TUMORS. PART 4). (MULTISCINTIGRAM. PART 2). Minoru Tsukamoto (Kurume Univ. School of Medicine, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 997-1019(Dec. 25, 1962). (In Japanese)

To evaluate the external diagnosis of tumors making use of the uptake of ^{32}P by the tumors, fundamental experiments on ^{32}P Bremsstrahlung were done, and its application in mice injected with Ehrlich sarcoma into the femoral regions was studied. The energy distribution of Bremsstrahlung ranges up to 1.7 Mev, but the measurement of the part in the lower energy range (< 100 kv) is important for detection of Bremsstrahlung, but the accuracy and stability of the present scintillation equipment is not adequate. With reflection targets, the intensity and the hardness of the radiation is proportional to the Z_{eff} of the target. With transmission targets when the target is thicker than β ray's maximum range, the radiation becomes harder in proportion to the Z_{eff} of the target, and the intensity decreases. In detection of Bremsstrahlung, the intensity of the radiation is too low for the differential method, and so the integral method must be used in spite of disadvantages. In animal experiments, injection of ^{32}P into mice inoculated with Ehrlich sarcoma was followed 3 to 120 hr later by β-ray counting with a G-M counter over the dissected liver, the tumor site, and for control the left femoral region. The β radiation was highest after 3 hr in the liver, tumor, and control tissue. The ratio of ^{32}P uptake of the liver to that of the control part was high after 3 to 48 hr, and the ratio for the tumor was high after 20 to 72 hr. Using the same materials, the Bremsstrahlung was counted with a scintillation counter, and similar results were obtained. When mice inoculated with the tumor were examined by external scanning the uptake ratio in the tumor began to increase after 18 hr after the injection and was highest after 36 hr. Uptake was recorded for 120 hr after the injection. After injection of 100 μC of ^{32}P to the mice inoculated with sarcoma, the scintigram was recorded for 3 to 120 hr using a multiscintigram system; the tumor was registered on the scintigram for 24 to 72 hr. The scintigram could be recorded with 50 μC of ^{32}P, and in this case the tumor was detected in 18 to 48 hr after the injection. (BBB)

10958 THE LOCAL BONE MARROW CHANGES FOLLOWING THERAPEUTIC TELECOBALT IRRADIATION. REPORT II: THE CHANGES OF 1000 r IRRADIATED CASES. Tatsuya Kurashina (Tohoku Univ. School of Medicine, Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 814-27(1963). (In Japanese)

Cytologic features in bone marrow were studied in 15 patients with malignant diseases whose sternums were γ irradiated with a telecobalt unit. Before and after irradiation at different doses (800 to 3000 R), sternal marrow aspirations were done and the smears were stained by the May-Giemsa and McJunkin methods. A reduction was seen in the number of total nucleated cell elements in the irradiated bone marrow, with a more marked decrease of the younger cells (myeloblasts, erythroblasts, normoblasts). The decrease of monocytes and reticuloendothelial cells was less than that of neutrophils and lymphocytes. After an exposure of 1000 R the total nucleated cell count was reduced to 17%, but still many immature elements (promyelocytes, myelocytes, normoblasts) were seen, and even myeloblasts in one case. Megakaryocytes (and mitotic figures) were still present, but had degenerated moderately. In peripheral blood there was a moderate reduction of leucocytes but no change in erythrocytes. The leucopenia consisted mostly of a decrease of lymphocytes. The sternal marrow of 2000-R-irradiated cases showed the nucleated cell count reduced to 8.8%. Myeloblasts, megakaryocytes, juvenile elements of eosinophils, and mitotic figures had disappeared, and juvenile forms of neutrophils and nucleated red cells had almost disappeared. The sternal marrow after 800-R irradiation showed the nucleated cell count reduced to 55%. Myeloblasts and erythroblasts disappeared, but the other immature forms were present at a level of 1 to 5%. Thirty days after irradiation the nucleated cell count was a little further reduced but the myelogram was otherwise normal. The sternal marrow changes in the 2000-R-irradiated cases were similar to those of 3000-R group, while the changes after 800 R were almost the same as those of 1000-R group. It is concluded that the sternal marrow after 2000-R irradiation shows moderate hypoplasia, as seen in the 3000-R group, while in 1000-R-irradiated cases injury to hematopoiesis is less and moderate recovery of the bone marrow occurs. (BBB)

10959 CALCULATION OF THE ABSORBED DOSES OF PRIMARY X-RAY. Chikara Takei (Nagasaki School of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1456-9(Mar. 1964). (In Japanese)

By means of scintillation spectrometry, spectral distributions of the primary and secondary x rays from a therapy machine of Greinacher circuit were measured (1959). The absorbed doses f (in terms of Rad/R for various half value layers) of primary x ray for water, muscle, and bone were calculated. These calculated values were compared with those published in NBS Handbook 62. While coincidence with data published by others was fairly good in the absorbed doses for water and muscle, considerable discrepancy was found in those for bone, probably due to the fact that relative f values of low-energy x rays in bone are greatly influenced by different spectral forms of x rays from different generators and filters. Consequently, absorbed doses for water and muscle may be obtained without gross error from the curves of absorbed dose-half value layer relationship published in NBS Handbook 62. However, absorbed doses for bone should be calculated from data obtained from measurements of energy spectrum or ionization of equivalent gas. (auth)

10960 A METHOD OF SKIN DOSE CALCULATION FOR ARC THERAPY WITH MEDIUM ENERGY X-RAY AND RI γ-RAY. Takeshi Yamazaki and Yasushi Shigematsu (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1538-48(Mar. 1964). (In Japanese)

A theoretical term of cross-sectional field size is proposed after some considerations on the definition of the term field-size for the diaphragm-limited beam. Some measurements were taken of the skin dose. For a theoretical primary beam having no penumbra, uniform dose distribution, and no deviation from inverse-square law, let the cross-sectional width of this theoretical beam, equivalent to the practical beam on numerical calculation, be W′ cm at skin position. So W′ may not be equal always to the 50% dose line (width) of the practical beam. If it is assumed that this theoretical beam passes perpendicular to the infinite water surface and total scatter dose both inside and outside of the beam may be given uniformly during irradiation, irradiation time corresponds to the above mentioned effective cross-sectional width of the beam W′ and the effective backscatter factor ϵB may be defined for arc therapy. A formula is given for calculating average skin dose rate of one arc movement. (A.G.W.)

10961 VAGINAL CYTOLOGY FOLLOWING RADIOTHERAPY FOR CARCINOMA OF THE CERVIX. John T. Jenkins and C. V. Allen (Univ. of Oregon, Portland). Northwest Med., 63: 41-2(Nov. 1964).

Cytologic findings were analyzed in 141 patients who were treated with intracavitary radium and orthovoltage external irradiation with a 2-Mev Van de Graaff generator. Although the cytology seemed an accurate index of presence or absence of carcinoma in 82% of the cases, 18% were misleading. This represents 9% false positives and 9% false negatives. Of 31 patients with persistent disease, the smear was accurate in only 56%. (TCO)

10962 RADIOISOTOPES IN HEMATOLOGY. Marcel E. Conrad, Jr. (Walter Reed Army Inst. of Research, Washington, D. C.). Nucleonics, 23: No. 2, 76, 78-9(Feb. 1965).

Radioisotopes are used in hematology in two major areas. The therapeutic effects of radiation are used to suppress the formation of abnormal cells and control the rate of production of cells in conditions in which proliferation is excessive. In addition, methods of labeling cells and biochemical substances provided methods for studying metabolism and kinetics in the body. ^{32}P was found to be most valuable in treating hematologic disorders. Uses of radioisotopes in blood-volume determinations, blood loss measurement, cell destruction studies, absorption and excretion measurements, and kinetic studies are discussed. (M.C.G.)

10963 A COMBINATION THERAPY OF MOUSE SARCOMA 180. P. Tomashefsky, S. Baum, and C. Funk (Funk Foundation for Medical Research, New York). Oncologia, 17: 1-6(1964).

To evaluate the effectiveness of combination therapy of Sarcoma 180 in mice, studies were made to determine the minimum effective dosage of the several agents and whether a synergistic action could be observed between agents. It was previously shown that Oncotine (from beef spleen) shows synergism with the nitrogen mustard Nitromin (methyl-bis-(-chloroethyl)-amine-N-oxide). At nontoxic levels their combined effect was 55% greater than the sum of the effects of the individual components. Therefore, the actions of Oncotine and Nitromin were combined with low dosage whole-body x irradiation. Irradiation was performed with a therapeutic machine operated at 140 kv and 14.4 R/min. Doses varied from 75 to 270 R. These experiments demonstrated that, while the total effect of the combination was not as great as the sum of the activities of the individual components, there is a notable cumulative antitumor action. Since the effect of radiation doses lower than 250 R was not as marked as it was at that level, Oncotine alone was tested with two different x ray doses. Only the upper dose (250 R) was able to increase inhibition of the tumor over that of Oncotine alone. In attempts to obtain maximal inhibition of tumor growth, an experiment was run for 11 days using Oncotine and 270 R, but it was not possible to completely inhibit Sarcoma 180 by this procedure. However, the observed tendency towards increased inhibition of tumor growth offered hope that a suitable system may be obtained. The value of using low radiation levels in conjunction with chemotherapeutic agents is discussed. It is recommended that x radiation be reduced to a minimum while applying the combined therapy of natural, and/or synthetic antitumor agents. (BBB)

10964 LOCAL IRRADIATION OF THE TONGUE BY MEANS OF INTRA-ARTERIAL ^{198}Au INJECTION: EXPERIMENTAL STUDY. P. Rossotto, V. Stancanelli, P. Georgacopulo, and S. Guerrieri (Università, Sassari, Italy). Panminerva Med., 6: 304-8(Sept. 1964).

Preliminary to the development of a clinical technique for irradiating tumors of the tongue, studies were conducted in dogs on the distribution of colloidal ^{199}Au and ^{198}Au adsorbed on carbon within the tongue under various hemodynamic conditions. When ^{198}Au was adsorbed on carbon particles (20–40 μ in dia), it was more suitable for this purpose as it caused microemboli in the precapillary arterioles. In this way it was possible to obtain a localized radiation source and reduce leakage to the venous bed to a minimum. The anatomical arrangement of the vascular bed of the tongue made it comparatively simple to evaluate leakage or residual radioactivity after ^{198}Au injection into the arterial circulation of the tongue. Into the lingual artery of anesthetized dogs 5 mC of colloidal ^{198}Au or ^{199}Au adsorbed on carbon was injected with or without occlusion of the ipsilateral vein. In its colloidal form ^{198}Au was not adsorbed by the tongue muscle but escaped rapidly into the bloodstream, even with ligation of the ipsilateral lingual vein, and created undesired sources of radiation, especially in the liver. When it was adsorbed on carbon ^{198}Au, it appeared to offer a useful therapeutic tool since it was taken up by the vascular areas into which it was introduced due to its physical features (particle dia of 40 μ). Leakage was minimal and further reduced by venous block. It is concluded that local irradiation of malignant tumors of the tongue by intra-arterial injection of ^{198}Au adsorbed on carbon together with venous occlusion is a valid clinical procedure which can be adopted as an adjunct to or substitute for surgical excision. (BBB)

10965 MEDICAL CARE IN CASES OF PATIENTS WITH NEOPLASTIC TUMORS IN COURSE OF RADIOTHERAPY. Miroslaw Ulkowski. Polski Przeglad Radiol. i Med. Nuklearnej, 28: 531-8(Nov.-Dec. 1964). (In Polish)

Reactions and complications detected during and after radiotherapy are discussed. Radioprotective measures and methods for treating radioinduced complications are considered. (H.M.G.)

10966 THE CLINIC AND PREVENTION OF POST-IRRADIATION NEPHRITIS. Juliusz Borejko. Polski Przeglad Radiol. i Med. Nuklearnej, 28: 555-64(Nov.-Dec. 1964). (In Polish)

The postradiation nephritis is presented as a severe complication in cases where the lumbar region is irradiated

because of neoplastic tumors. The value of proper protection of the kidneys in course of irradiation is stressed. (auth)

10967 COBALT TELEGAMMATHERAPY USING GUT-400 AND RADIOLOGIC PROTECTION. B. Lubas, W. Lobodziec, P. Rattka, and L. Tyrala. Polski Przeglad Radiol. i Med. Nuklearnej, 28: 565-74(Nov.-Dec. 1964). (In Polish)

Dose distribution in clinics using ^{60}Co radiotherapy with the GUT-400 apparatus is discussed. Dosimetry of the fully loaded device was determined for patient resting positions during irradiation and for various personnel working positions. Effects of types of radiation (primary, dispersed, and transduced) on total dose are considered. Radioprotective measures are presented for staff members working with the GUT-400. (H.M.G.)

10968 RETICULOENDOTHELIAL SYSTEM STUDIES WITH RADIO COLLOIDS. G. V. Taplin, E. K. Dore, E. J. Garcia, and D. L. E. Johnson (Univ. of California, Los Angeles and Los Angeles County Harbor General Hospital, Torrance, Calif.). Proc. Intern. Congr. Hematol., 9th, Mexico City, 1962, 3: 439-49(1964).

The use of labeled colloids and external counting for studies on the physiology of the reticuloendothelial system is discussed. Emphasis was placed on use of the technique to determine morphological abnormalities of the liver and spleen and in the diagnosis of hepatobiliary diseases and acute infectious or inflammatory states. Results are reported from measurements of the uptake of colloidal ^{198}Au and liver blood flow in subjects with cirrhosis, hepatitis, biliary obstruction, or alcoholism and measurements of the phagocytic function in patients with Hodgkin's disease, cirrhosis, acute bacterial infections, pulmonary tuberculosis, heart failure, infectious hepatitis, and dermatitis determined by measurements of the metabolism of ^{131}I-labeled human serum albumin. The effects of therapeutic doses of x radiation on phagocytic activity were measured in patients with Hodgkin's disease. No anaphylactoid reactions, skin reactions, or albumin antibodies were observed in patients having multiple tests using ^{131}I-albumin. (C.H.)

10969 ^{85}KRYPTON IRRADIATOR WITH SPECIAL REFERENCE TO THE RADIATION PROTECTION PROBLEM IN DERMATOLOGY. W. Degner, H. Hegewald, and Th. Thormann (Universität, Berlin). Radiobiol. Radiother., 3: 621-31(1962). (In German)

The advantage of the β irradiator is that the depth dose plateaus and then falls off abruptly to zero. Dermatological treatment with ThX preparations should not be undertaken because of the radiation protection problems that its use entails. Generally, it is used as an unsealed radioactive source, and it is difficult to control it enough to maintain the safety precautions necessary. Also, its use may contribute significantly to the genetic burden of the patient. The radioactive decay scheme of ^{85}Kr indicates that it has a half value thickness in tissue of ~0.4 mm. The maximum penetration depth of particles from Kr is ~2.5 mm of tissue. This value is optimal for many skin disorders, compared to other emitters, such as ^{32}P or ^{90}Sr-^{90}Y, which penetrate more deeply. Absorption characteristics of its β and γ radiation are very similar to those of Th. Preparations containing 100 mC of ^{85}Kr can readily be incorporated into β applicators. The bremsstrahlung dose exposure from this type of applicator are of the order of magnitude of 15 mr/hr to the hand and less than 0.5 mr/hr to the gonads and eyes. For critical organs and hands the ratio of the highest permissible dose values is 1:15, while measurements with the ^{85}Kr applicator give a ratio of 1:30. Therefore, the total usage time for this applicator is limited by the radiation exposure to the hands, amounting to 100 hr/week. With the 100 mC applicator radiation times per patient are from 1 to 30 min. If the average surface area to be irradiated is 10 cm^2, the radiation time per patient is 6 min, with a bremsstrahlung dose of 1.5 mr. Thus, 1000 patients could be irradiated each week before the permissible dose would be exceeded. The dose to the critical organs would be far below this limitation. Although ^{85}Kr cannot be used for all skin disorders, it can be substituted for Th. Keeping its lower price and depth effect in mind, it is also much less dangerous to use than are Sr-Y applicators. (BBB)

10970 STUDIES OF THE EFFECTIVENESS OF X RAY TREATMENT OF PITUITARY ADENOMA, DIENCEPHALIC SYNDROMES, AND AUTONOMIC DISTURBANCES OF THE BLOOD BROMIDE PATTERN. M. Ch. Fajzullin and I. Ch. Galimov (Municipal Inst. for Medical Training, Kazan). Radiobiol. Radiotherap., 3: 481-9(1962). (In German)

X-ray treatment may be effective in reestablishment of cortical-subcortical relations, in the normalization of hypothalamic functions, and for treatment of pituitary adenoma. The dynamics of the blood Br level was used as a clinical symptom to measure the effectivity of x-ray treatment of these disorders, because it is regulated to a large extent by the autonomic centers located in the hypothalamic region and the pituitary. X radiation therapy was administered to 64 patients for several related conditions. Of these patients, 23 had pituitary adenoma, 10 were acromegalic, 7 displayed Cushing's syndrome, 6 had adiposogenital syndrome, 17 had diencephalic syndromes, and 24 had marked autonomic disturbances with multiple sclerosis. Their ages ranged from 20 to 50 yr, and the duration of their illnesses ranged up to 10 yr. The surface dose given per field for pituitary adenoma was between 125 and 200 R, and for diencephalic syndrome the single field dose was between 50 and 100 R. For the multiple sclerosis cases the single field dose was between 100 and 150 R. The total dose per series varied widely, ranging from 325 to 5200 R, and depended on the disease condition treated. Blood Br levels were measured before, during, and after the irradiations. Supplemental treatments of vitamins and glucose infusions were also administered. The normal blood Br level was from 0.2 to 1.91 mg%. In the adenomas and diencephalic syndromes it was from 1.16 to 5.06 mg%. X ray therapy was effective in 36 of the patients in reducing the blood Br level when it was given in a series of five irradiations that ranged from 1000 to 2100 R, administered over a period of three yr. When the initial Br blood level was very high, the amount of the decrease observed was most pronounced. In 6 patients the Br level increased, along with increased severity of their symptoms. (BBB)

10971 EVALUATION OF THE RISKS OF IRRADIATION INVOLVED IN SYSTEMATIC RADIOLOGICAL CHEST EXAMINATIONS. Ch. Gernez-Rieux, G. Bonte, M. Gervois, and E. Spy. Rev. Tuberc. (Paris), 27: 475-82(Apr. 1963). (In French)

The extensive documentation amassed by the International Union Against Tuberculosis in 1958 clearly demonstrated the reduced amount of irradiation now being used in radiophotography for detection of tuberculosis. This survey was based on 34,077,169 x-ray photographs taken in 58 different services in various European countries and Canada. With the apparatus available at that time, irradiation doses varied between 200 and 600 mR. The 1958 survey was valuable in that it focused attention on the types of x-ray apparatus which were most economical for use in diagnostic radiography. This survey stimulated further improvement in equipment, the features of which are described. A comparative study was made utilizing four different brands of apparatus used in mobile radiophotographic units designed for tuberculosis detection. One of these possessed an autorectifier tube permitting higher voltages to be used. The three others were equipped with four semiconductor rectifiers. Many dosimeter studies were made with different types of apparatus. Results showed that the patient exposure dose was 200 mR if an autorectifier-equipped apparatus operated at 90 kv was used. An increase in voltage reduced this dose to 140 mR in the adult and 30 mR in the child. With the semiconductor rectifier type, by raising the tension from 80 to 125 kv, the radiation dose to the subject can be reduced from 148 to 120 mR. This dose can be further reduced, by increasing filtration and the focal distance, to 85 mR or even 61 R. In children the possibility exists of reducing radiation to 40 or 50 mR, while still obtaining excellent radiographs. Radiography, fluoroscopy, and radiophotography of the lung were compared.

Exposure dose in radiophotography was found to be two to four times lower than that necessary for fluoroscopy. Disadvantages of fluoroscopy, other than those involving the high dose to the subject, are enumerated. (BBB)

10972 HISTORY OF MEDICAL RADIOLOGY. IV. DIAGNOSIS. V. Cornacchia. Riv. Storia Med., 8: 105-22 (Jan.-June 1964). (In Italian)

10973 CLINICAL APPLICATION OF ^{24}Na-CLEARANCE DURING STANDARD EXERCISE IN CHRONIC ARTERIAL THROMBOSIS. K. H. Toennesen (Bispebjerg Hospital, Copenhagen). Scan. J. Clin. Lab. Invest., 15: Suppl., 76: 64-5(1963).

A new method using ^{24}Na was developed for the purpose of obtaining, for clinical use, a relative measure of the arterial capacity in the extremities. In both healthy subjects and patients with claudication, a relatively large volume of isotonic saline solution is injected to avoid the error arising from placing the depot in close contact with only a single muscle fiber. Exercise is begun after the period of initial rapid clearance has expired. The influence of variations in site of the ^{24}Na depot is eliminated by using the ratio between the clearance during the exercise period and that of the subsequent period; this gives a relative measure of the capacity of the feeding vessel. The depot solution (5 μC^{24}Na) is injected to a depth of 2 cm into the thickest part of the posterior aspect of the calf. A scintillation crystal at a distance of 25 cm from the depot is connected to a rate-meter and an automatic recorder. The half-time of the clearance ($t_{\frac{1}{2}}$) for the period before exercise, $to_{\frac{1}{2}}$, during exercise, $te_{\frac{1}{2}}$, and the resting period after exercise, $tpe_{\frac{1}{2}}$, are calculated by plotting cpm against time upon semilogarithmic paper. The ratio: $tpe_{\frac{1}{2}}/te_{\frac{1}{2}}$ is termed the capacity quotient, c.q. A diseased leg shows a longer $te_{\frac{1}{2}}$ and a shorter $tpe_{\frac{1}{2}}$ than a normal leg. The longer $te_{\frac{1}{2}}$ indicates presumably a diminished arterial capacity, while the shorter $tep_{\frac{1}{2}}$ may be a consequence of the oxygen debt. Consequently the c.q. will be lower than normal in patients with intermittent claudication. In young healthy subjects the average c.q. was 4.1, varying from 2.2 to 8.8. In legs with arteriographically demonstrated thrombosis, the average c.q. was 1.5 varying between 0.7 and 2.4. (BBB)

10974 THE SIGNIFICANCE OF RECIRCULATION FOR THE DETERMINATION OF INTRARENAL BLOOD FLOW DISTRIBUTION WITH KRYPTON-85 AND XENON-133. J. Ladefoged (Glostrup Hospital, Copenhagen). Scand. J. Clin. Lab. Invest., 16: 479-80(1964).

A new method for the measurement of intrarenal blood flow distribution in the unanesthetized dog by means of ^{85}Kr is considered. Injection of the isotope into the renal artery is followed by a multiexponential disappearance curve obtained by external monitoring with a scintillation detector. On the basis of earlier studies it was concluded that the first exponential component represented cortical blood flow; the second, outer medullary blood flow; the third, inner medullary blood flow; and the fourth, hilar and perirenal fat blood flow. For this calculation of blood flow distribution from the disappearance curve from the kidney, an important assumption is that the amount of indicator returning to the kidney is zero or very small. To evaluate a the validity of this assumption, examinations were performed in four patients with essential hypertension. Krypton-85 or ^{133}Xe dissolved in sterile isotonic saline was first injected in a peripheral vein while the build-up and subsequent wash-out curve was measured over one of the kidneys with a scintillation detector, ratemeter, and recorder. Then the same amount of indicator was injected into the renal artery via a catheter introduced from the femoral artery, and the disappearance curve was again measured from the kidney. The peak values for the recirculation curves were somewhat higher for ^{133}Xe than for ^{85}Kr, or about double. An analysis was made of the extent to which this recirculation influences the calculated blood-flow data. The results show that recirculation of indicator may give rise to considerable errors in the estimation of renal medullary flows. Without some correction for this phenomenon it is not possible to calculate the blood-flow in the deeper parts of the medulla with the arterial injection and external counting technique using ^{85}Kr or ^{133}Xe. However, the method seems valuable for the measurement of renal cortical blood-flow, and it will probably give reasonable accurate figures for the flow in the outer medulla. (BBB)

10975 THE CURRENT STATUS OF RADIATION TREATMENT OF NEUROLOGICAL DISEASES. E. Zdansky (Universität, Basel). Schweiz. Med. Wochschr., 93: 1316-20(1963). (In German)

Radiation has a limited but by no means small significance for treatment of neurological diseases. Many times it is possible to prolong survival time or increase the frequency of cure by postirradiation of extremely malignant brain tumors that have been removed by radical surgery. Some inoperable, but relatively radiosensitive tumors, such as medulloblastomas, pinealomas, and ependymomas are amenable to what is essentially a palliative radiation treatment, but cures for these by irradiation are rather rare. Some reticuloses, such as lipoid granulomas or eosinophilic granulomas, have a good prognosis with radiation treatment, provided they are restricted to the skull. Pains, paresthesia, and paresis may arise directly from injuries to the nervous tissue, or may result from mechanical pressure from a space occupying malignant lesion. The success of radiation treatment here will depend on whether the lesion is radiosensitive and whether the brain tissue has been irreparably damaged. In radiosensitive metastatic tumors of the endocrine glands, such as lymphosarcomas, lymphadenomas, or reticulosarcomas of the hypophysis, thyroid, or thymus, radiation treatment is effective. Metastases of seminomas, testicular teratomas, sympathicogoniomas, bronchial, mammary, or ovarian carcinomas can be treated with radiation to reduce the accompanying symptoms. Treatment with conventional x ray may consist of 4000 to 5000 R given in 5 or 6 weeks. Treatment with a telecobalt source may amount to 5000 or 6000 R given in 6 weeks. When ^{60}Co or Rn seeds are implanted the total tumor dose used may be 6000 to 8000 R. It is likely that ionizing radiation may have functional effects on peripheral and central autonomic centers to alleviate neurological symptoms, but its mechanism of effect is unknown and the therapeutic effect is difficult to predict. (BBB)

10976 PRECAUTIONS IN THE RADIOGRAPHY OF FEMALE PATIENTS. Walter M. Whitehouse (Univ. of Michigan, Ann Arbor). Univ. Michigan Med. Bull., 30: 178-9(July-Aug. 1964).

In x-ray examinations of female patients in the childbearing age consideration should be made of possible existing pregnancy, by establishing the menstrual history. X-ray examination can then be carried out during the two weeks following a menstrual period, thus eliminating the possibility of exposing a very early embryo to x rays. The use of rapid pregnancy-determining hormonal tests may be helpful in avoiding x-ray exposure in patients with early pregnancy. Fluoroscopic examinations involving abdominal and pelvic exposure in females of childbearing age should utilize the dose reduction advantages of image intensification, particularly in uterosalpingography. In the pregnant patient, radiographic exposures should be limited to those actually and urgently needed. Except for a routine chest survey film as a part of antenatal care, x-ray investigations should be postponed until the postpartum period. In urgent situations, when they cannot, the pregnant uterus should be shielded from the direct beam and a min of exposures made to obtain the necessary information. In the postmenopausal patient no consideration of gonadal exposure is necessary. While general measures are utilized to reduce radiation, no special gonadal shielding is indicated and detailed diagnostic studies of the abdomen and pelvis may be carried out without further concern. By taking advantage of every dose reduction factor in female infants, children, and potential childbearing adults, the exposure of genetic material can be held to a minimum. (BBB)

10977 UROLOGICAL COMPLICATIONS OF GENITAL CARCINOMA AFTER RADICAL SURGERY AND RADIO-

THERAPY. H. Guenther (Landesfrauenklinik, Magdeburg, Ger.). Zentr. Gynaekol., 84: 1283-92(1962). (In German)

Nearly half of all cervical carcinoma patients show ureteral complications after radiation treatment. In 50 patients treated for cervical carcinoma, who subsequently developed urological complications, 38% died, with symptoms of uremia. In 90% of these cases marked ureteral stenosis and hydronephrosis were found at autopsy. In two these complications resulted from an operation and no carcinomatous tissue was found. In 10 out of 17 patients treated for recurrence of cervical carcinoma several urological injuries were observed even before the retreatment. A urological study of 136 patients who were clinically free of any recurrence of genital carcinoma was made from ½ to 6 yr after they had been treated. The type and stage of the carcinoma was compared with the degree of urinary tract injuries. Of these, 87 had no injuries, 31 had slight injuries, and 18 showed severe injuries. The less severe injuries consisted of radiation cystitis, delayed excretion of dye, bullous edema of the trigonum vesicae, and trigonal cystitis, with fibrosis and hemorrhage. Radiation cystitis is often an indication of later, more severe injury, such as ureteral cicatrization or stenosis, and is accompanied by pervivesicular inflammation. Acute infections of the urinary tract, often favored by radiation treatment, should be treated with broad spectrum antibiotics, or sulfonamides, provided that there are no contraindications. Chronic infections associated with emptying defects of the upper ureteral tract and urinary bladder are difficult to treat. The most severe injuries observed in the patients consisted of unilateral obstruction of the kidney pelvis, ureteral stenosis, contracture, or atonia, retracted bladder, or cystitis. These occurred alone, or in association with one another. (BBB)

CHEMISTRY

General

Refer also to abstract 12770.

10978 (UJV-1193/64) A STUDY ON URANYL PHOSPHATES. I. SORPTION PROPERTIES OF URANYL HYDROPHOSPHATE AS COMPARED WITH THOSE OF ZIRCONIUM PHOSPHATE. V. Pekárek and M. Benešová (Československá Akademie Věd. Ustav Jaderného Výzkumu, Řež). [1963]. 23p. Dep.(mn).

Synthesis, analysis, and properties of uranyl hydrophosphate are described. The sorption of some 1- to 4-valent cations and the separation of alkaline cations on uranyl hydrophosphate have been studied. For alkaline cations, the sorption has been compared with the results obtained on zirconium phosphate, and the separation of alkaline cations on these sorbents was studied. For the sorption mechanism, qualitative conclusions have been deduced and the selectivity coefficients for the pairs of ions $Cs^+ - NH_4^+$, $Cs^+ - Na^+$, $Cs^+ - K^+$, and $Cs^+ - Rb^+$ have been determined. (auth)

Analytical Procedures

Refer also to abstracts 11406, 11493, 11787, and 12488.

10979 (AERE-R-4747) THE DETERMINATION OF ACTINIUM-227 IN EFFLUENT. B. A. Loveridge, M. S. Gordon, and J. R. Weaver (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1964. 25p. Dep.; $0.70(BIS); 3s.6d.(HMSO).

Actinium is recovered from a one-liter aliquot of effluent by coprecipitation with ferric hydroxide. If algae are present, the precipitate is dissolved in acid and oxidized with nitric and perchloric acids before adjusting the acidity to pH 1.6 and extracting the actinium with di-(2-ethylhexyl)-orthophosphoric acid in heptane. The actinium is back-extracted into 1.5N hydrochloric acid and the solution is passed down an anion exchange column to remove traces of lead, bismuth, and polonium. The eluate containing the actinium is evaporated. Following an overnight delay to permit the major part of any actinium-228 to decay, the residue is dissolved in dilute acid and fed to a reverse phase partition chromatography column (di-(2-ethylhexyl)-orthophosphoric acid in toluene supported on poly(-vinyl chloride/vinyl acetate) copolymer) to separate actinium from the rare earths and from its own daughters which have grown in again overnight. The eluate is evaporated and the residue taken up in dilute acid to be mixed with a liquid scintillator for beta counting. Radiochemical recoveries range from 80 to 95% and decontamination factors from other nuclides are equal to or greater than 1×10^5 for those tested. (auth)

10980 (EURAEC-1273) DETERMINATION OF TRACE-ELEMENTS IN IRON SAMPLES BY NEUTRON-ACTIVATION TECHNIQUES. Technical Report No. 2. (Società Ricerche Impianti Nucleari, Milan). Nov. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 004-63-10 TEEI (RD). 54p. (R/352). Dep.(mn); $3.00(cy), 1(mn) OTS.

A systematic analytical procedure for the determination of some trace impurities in iron matrices was developed by employing both direct and destructive neutron-activation techniques. Irradiations in fast neutron fluxes, selective activation in epithermal neutrons, and coincidence γ-spectrometry measurements were used in some cases, in order to improve the sensitivity for nondestructive analysis; for destructive methods, radiochemical separations based on ion-exchange and solvent extraction were applied. The procedure is described, and the related precision is evaluated; some results of the determination of low concentration in iron of Al, Mn, Ti, V (non-destructive), P, S, Zn (destructive), and As, Co, Cr, Cu, Mo, Ni, Sc, W (both methods) are reported and discussed. (auth)

10981 (KR-80) ACTIVATION ANALYSIS OF IODIDE IN BIOLOGICAL FLUIDS. J. B. Dahl, O. Johansen, and E. Steinnes (Norway. Institutt for Atomenergi, Kjeller). Dec. 1964. 10p. Dep.(mn).

A method is described for activation analysis of iodide in biological fluids. The method is based on adsorption of iodide on an anion exchange resin, neutron activation of the resin, elution of the induced iodine-128, and separation from other activities by solvent extraction. The method was used to determine iodide in human urine and was found useful at iodide concentrations down to 0.0004 ppm in volumes not exceeding about 250 ml when applying a flux of about $3 \cdot 10^{12}$ n/cm² sec. The method is applicable in general for determination of inorganic iodine in aqueous solutions. (auth)

10982 (PG-Report-614) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF IRON AND NICKEL IN URANIUM TETRAFLUORIDE PRODUCED BY THE FLUIDISED BED PROCESS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1965. 6p. Dep.; (BIS)

The sample is dissolved in a mixture of nitric and boric acids and aliquots of the resulting solution are taken for iron and nickel determinations. Iron is determined absorptiometrically as the thioglycollate after decomposition of the uranyl thioglycollate with ammonium carbonate. Nickel is determined absorptiometrically as the dimethylglyoxime complex after oxidation with bromine water. The method is suitable for samples of 'Fluidised Bed' uranium tetrafluoride containing up to 1% iron and 1% nickel. The following precisions were calculated from the results of the analysis of standard samples by a number of different operators: Iron, mean = 104 ppm Fe; standard deviation = 6.0 ppm Fe. Nickel, mean = 40 ppm Ni; standard deviation = 1.7 ppm Ni. (auth)

10983 (TEES-2671-3) AN INVESTIGATION OF COMPUTER-COUPLED, AUTOMATIC ACTIVATION ANALYSIS. Annual Report. (Texas. Agricultural and Mechanical Univ., College Station. Engineering Experiment Station. Activation Analysis Research Lab.). Jan. 1, 1964. Dep.; $5.00(cy), 3(mn) OTS.

The feasibility of automation and computer methods to instrumental activation analysis is evaluated. The first activating source, spectrometer, and data processing grouping consists of a nuclear reactor, an automated gamma spectrometer, sample transfer system, and an IBM-709 computer. The Mark I-Ia System served as the prototype for a more sophisticated and higher capacity automated spectrometer, called the Mark II System. The Mark II utilizes magnetic tape readouts and has three separate detector-analyzer sets. The use of these systems is illustrated by evaluating the following information: silver in rat brain tissue; selenium analyses; determination of tellurium in blood, urine, and water; dysprosium used as an indigestible marker; and moon probe developments. Information is also given on dynamic subtraction of spectra, AA-4 computer program for unscrambling gamma spectra, and high-speed accumulation of isotope data using digital and analog systems. (N.W.R.)

10984 (UCRL-11780) REACTIONS OF He^3 WITH LIGHT ELEMENTS: APPLICATIONS TO ACTIVATION ANALYSIS (thesis). John D. Mahony (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1965. Contract W-7405-eng-48. 66p. Dep.(mn); $3.00(cy), 2(mn).

A simple, rapid technique of analyzing for carbon, oxygen, and fluorine, individually and simultaneously by ^3He activation is presented. This method, which can easily be

extended to other elements, is capable of analyses at the ppb level or even less in some cases and an ultimate accuracy of 5%. Milligram amounts of total sample are sufficient and are not destroyed in the analysis. The advantages of this technique with especial reference to energetics, versatility, and the elimination of interferences are discussed and compared to those of other charged-particle and neutron-activation analysis procedures. The excitation functions for the production of ^{18}F from ^{16}O, ^{11}C and ^{13}N from ^{12}C, and ^{18}F from ^{19}F by ^{3}He reactions for the energy range, 0 to 31 Mev have been determined and are discussed with particular application to activation analysis. An absolute analysis for oxygen in thorium was performed; simultaneous absolute analyses of gold, silicon, Mylar, and polyethylene for carbon and oxygen, and Teflon for carbon and fluorine are described. Results of analyses by the relative method for oxygen in thorium, beryllium, niobium, and lead are also reported. Although the Berkeley Hilac was used for the work described, a small cyclotron is shown to be quite adequate for extensive ^{3}He activation analysis. The specifications of such an accelerator are given. (auth)

10985 (AEC-tr-6227/3(p.193-200) EXTRACTION OF COPPER AND ITS DETERMINATION BY RADIOACTIVATION ANALYSIS. D. B. Stevančević and G. T. Hajduković. Translated from Bilten Inst. Nukl. Nauke "Boris Kidric," 15: 193-200(1964).

A procedure for separating ^{64}Cu from samples of aluminum alloys, steel, magnesium, and plant ashes is described. The separation was carried out by extraction with a chloroform solution of 1-phenyltetrazol-5-thiol. It was shown that from irradiated samples radiochemically pure copper can be extracted and separated from a number of elements. The separated copper was determined radiometrically. (auth)

10986 NEW RADIOMETRIC METHOD FOR THE DETERMINATION OF TRACE AMOUNTS OF CHLORIDE IONS: INVESTIGATION OF THE SYSTEM SILVER CHLORIDE. K. Burger (Eötvös Univ., Budapest). Acta Chim. Acad. Sci. Hung., 40: 17-29(1964).

A new radiometric method, developed for the determination of trace amounts of chloride (1 to 10 μg/ml), is based on the dependence of the solubility of silver chloride on the concentration of chloride ions. The actual chloride content can be calculated from the decrease of solubility on the effect of rising chloride concentrations. Solubility is determined by radiometry with the aid of a solubility column filled with silver chloride labeled with ^{110m}Ag. The solubility of silver chloride is proportional to the activity of the solution equilibrated with the precipitate, and with the knowledge of the specific activity of the silver chloride, solubility can be calculated from the measured number of impulses per unit time. It was found from the solubility curve of silver chloride that the method is best used in the concentration range from 10^{-3} to 10^{-5} moles/liter. The accuracy of the measurements in the lower range of chloride concentration (3×10^{-4} moles/liter) markedly exceeds that of those over this limit, and the method proved quite unsuitable for use over the chloride concentration 10^{-3} moles/liter. The anomalous behavior is due to the rise of the solubility of silver chloride with the decrease of chloride concentration in the solution. The method is not affected by acidity. Trace amounts of chloride were successfully determined in up to 2.0M solutions of perchloric acid. However, with salts undergoing alkaline hydrolysis, it is best to acidify the solutions with chloride-free perchloric acid to a pH value between 1 and 2. Of the anions tested for interference, halides, sulfides, and cations mercury, lead, palladium, and thallium interfered with the determination. With the labeled silver chloride used in the experiments, the measured γ activity of 1 ml of 10^{-6} moles/liter silver solution was ~110 cpm. To eliminate radiation hazards, the solubility column was kept in a water bath of about 50 cm diameter. (TCO)

10987 POTENTIOMETRIC DETERMINATION OF THORIUM. G. Popa, E. Radulescu-Grigore and D. Negoiu (Univ. of Bucharest). Analele Univ. C. I. Parhon, Ser. Stiint. Nat., 11: No. 35, 64-7(1962).

A solution of $Th(NO_3)_4$ (0.555 g of Th/l) was acidified with concentrated HNO_3 (1 ml of HNO_3/1 of solution), and aliquots were titrated with EDTA solution (12.4 g/l) with use of an automatic titrimeter (calomel and Pt electrodes). The procedure was suitable for the determination of 0.8 to 22 mg of Th in the presence of UO_2^{2+} at a ratio of UO_2^{2+} to Th of 1 : 2, with an error of ±1.5%. The acidification was necessary to prevent the formation of a precipitate at pH > 3. (Anal. Abstr., 11: No. 9, Sept. 1964)

10988 SPECTROPHOTOMETRIC STUDIES WITH NUCLEAR FAST RED. G. Popa, G. Baiulescu, I. Paralescu, and D. Mircea (Univ. of Bucharest). Analele Univ. C. I. Parhon, Ser. Stiint. Nat., 11: No. 35, 77-86(1962).

Nuclear Fast red (C.I. Azoic Diazo Component 5) (I) was used as a reagent for the determination of La^{III} and Zr^{IV}. Maximum extinction of the La complex at 533 mμ was attained at pH 5.9 in a medium containing ethanol or acetone, and Beer's law was obeyed over the range 0 to 6 mg of La/l; the stoichiometric ratio of La to I in solution was 1 : 3. Maximum extinction of the Zr complex at 272 mμ was attained in 0.1N–HCl after 20 min, and Beer's law was obeyed over the range 0 to 6 mg of Zr/l. The stoichiometric ratio of Zr to I in solution was 1 : 2. (Anal. Abstr., 11: No. 9, Sept. 1964)

10989 STUDY OF A CHEMICAL AND ISOTOPIC METHOD OF LOCAL ANALYSIS USING SECONDARY IONIC EMISSION. THESIS. Georges Slodzian (Université de Paris, Orsay, France). Ann. Phys. (Paris), 9: 591-648(Sept.-Oct. 1964). (In French)

A method of microanalysis in which the primary particles bombard an extended area and the secondary ions emitted by the target are focused at an image of the object surface was studied using corpuscular optics. The principles of the developed assembly, consisting of the ion image former, its magnetic filter, and the image detector, are reported. The experimental apparatus and methods are described. Characteristics of secondary ion emission were studied, and the analytical conditions were defined. Some examples of applications are given. (J.S.R.)

10990 QUANTITATIVE DETERMINATION OF CARBON IN SOLID HYDROCARBONS USING THE INTENSITY RATIO OF INCOHERENT TO COHERENT SCATTERING OF X-RAYS. C. J. Toussaint and G. Vos (Euratom, CCR, Ispra, Italy). Appl. Spectry., 18: 171-4(1964).

A method is described for determination of carbon in solid hydrocarbons using the intensity ratio of incoherent to coherent scattering x rays. The method is very rapid with precision at the 95% confidence level of about ± 0.3%. The minimum sample weight necessary is 0.2 g. Analysis of samples by the x-ray method showed good agreement with values obtained by microcombustion. A general comparison between different methods for carbon determination in solid hydrocarbons is discussed. (auth)

10991 THE DETERMINATION OF BEAM POLARIZATION AND FLIPPING EFFICIENCY IN POLARIZED NEUTRON DIFFRACTOMETRY. P. J. Brown and J. F. Forsyth (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. J. Appl. Phys., 15: 1529-33(Dec. 1964).

The method of deriving magnetic scattering amplitudes from polarized neutron measurements is examined, and the importance of the correction factors for incomplete neutron polarization, incomplete spin reversal, and depolarization is discussed. A new method for the evaluation of the polarization is described, and a correction for depolarization was verified experimentally. A graphical method for the rapid evaluation of the magnetic scattering is proposed. The sources of experimental error were studied, and expressions for their magnitude were derived. (auth)

10992 THE UTILIZATION OF ION EXCHANGERS IN ANALYTICAL CHEMISTRY. G. Delarue, C. Poitrenaud, and M. Rastoix. Bull. Inform. Sci. Tech. (Paris), No. 85, 29-40(July-Aug. 1964). (In French)

Examples are used to illustrate the role played by ion

exchangers in various areas of analytical chemistry: quantitative and qualitative analysis, preparation of pure reagents, and study of reactions of complex formation. (J.S.R.)

10993 USE OF β RADIATION FOR THE DETERMINATION OF URANIUM AND THORIUM IN AQUEOUS SOLUTIONS. P. Toelgyessy and P. Dillinger (Inst. of Chemistry and Tech., Bratislava). Chem. Zvesti, 17: 439-44(1963).

The cell containing the sample (10 ml) is held, in a special device, near the radiation source (^{90}Sr), and the transmitted β-radiation is measured by a sensitive scintillation detector. (Anal. Abstr., 11: No. 9, Sept. 1964)

10994 THE DETERMINATION OF COPPER AND ZINC IN CERTAIN PHARMACEUTICALS BY MEASURING THE REFLECTED β-RADIATION. M. Šaršunová, J. Klas, and J. Toelgyessy. Chem. Zvesti, 17: 504-9(1963). (In Slovak).

The apparatus used consisted of a ring-shaped Tl^{204} β-radiation source, a scintillation probe with a β-scintillator and an automatic radiation counter. The sample solution was placed into a plexiglass cuvette with a polyethylene film bottom. The cuvette was mounted firmly on the radiation source casing. The intensity of reflected β-radiation was measured, and the concentrations were determined from a calibration curve. The $CuSO_4 \cdot 5H_2O$ was determined in concentrations in which it is normally used in gynecology (6 to 8%) and the $ZnSO_4$-$7H_2O$ in concentrations used for eye drops (0.3 to 1.25%). The results compared favorably with those obtained by iodometric and complexometric methods for Cu and Zn, respectively. The use of the scintillation counter made it possible to increase the sensitivity of the determination and to reduce the measuring time to 1 to 5 min. The method is suitable for serial analysis. (OID)

10995 NEUTRON ACTIVATION ANALYSIS OF TRACES OF PALLADIUM, GOLD, AND IRIDIUM IN SUPERNATES FROM THE REFINING OF PRECIOUS METALS. M. J. Herak and D. F. C. Morris (Brunel Coll., London). Croat. Chem. Acta, 36: 67-71(1964).

In the refining of precious metals it is desirable to be able to determine amounts of the elements remaining in solution after various precipitations. The application of neutron activation methods to the determination of traces of palladium, gold, and iridium is described. The reactor BEPO at Harwell was used as the source of neutrons and each of the three elements could be determined with high sensitivity in a 0.5-ml aliquot of a sample solution. Results of analyses for microgram and submicrogram quantities of palladium, gold, and iridium in the solutions under investigation showed good precision. (auth)

10996 THE DETERMINATION OF MOLYBDENUM, URANIUM, AND SILICON IN MOLYBDENUM AND URANIUM SILICIDES. B. Kamenar and M. Herceg (Univ. of Zagreb and Institut "Ruder Boskovic", Zagreb). Croat. Chem. Acta, 36: 95-7(1964).

Methods were developed for determination of Mo, U, and Si in MoSi and USi. Silicon was determined gravimetrically as silica by dehydration with perchloric acid. After volatilization of silicon in the presence of HF and HNO_3, the product was converted to MoO_3 by ignition in air and then weighed. Silicon was removed from the USi sample by decomposition in HF and H_2SO_4 mixtures. The residue was dissolved in H_2SO_4 and uranium determined by titration using potassium permanganate. (M.C.G.)

10997 THE INDUSTRIAL DEVELOPMENT OF ANALYSIS BY ACTIVATION. Gérard Robin and Jean-Pierre Vidal. Energie Nucl., 6: 365-70(Sept.-Oct. 1964). (In French)

Activation analysis, the technical problems of which are examined, is particularly interesting for trace determination, but can also be applied in the field of large quantities. These problems and the importance of the means which must be employed in an activation analysis laboratory still limit the development of this method. It is also of interest for industry to be able to call on the services of a specialized laboratory where the possibilities of the development of this technique are studied. (auth)

10998 BETA-GAMMA PHOTOMETER FOR QUANTITATIVE ANALYSIS BY ABSORPTION OF RADIATION. L. Weise. Glas-Instr.-Tech., 7: 304-5(1963).

The instrument described has several interchangeable ratioactive sources (e.g., ^{109}Cd, ^{3}H and ^{90}Sr) and a range of detectors for measuring the absorption of radiation caused by the interposition of a standard mass of sample material between the source and the detector. By preparing calibration curves for organic compounds having known contents of, e.g., Pb, S, Cl, C, and H, it is possible to report on the composition of unknown samples. (Anal. Abstr., 11: No. 9, Sept. 1964)

10999 PREPARATION OF RADIOACTIVE SAMPLES FOR MEASUREMENT. III. FOODSTUFFS, PLANTS, BLOOD, FAECES, AND AIR-BORNE DUST. D. E. Schmitt. Glas-Instr.-Tech., 7: 357-64(1963).

For milk samples, the albumin is precipitated and filtered off; heavy and alkaline-earth metals are precipitated from the filtrate as hydroxides or carbonates, then separated as oxalates. These groups of elements are substantially free from naturally occurring radioisotopes, and provide a reliable estimate of contamination. The α- and β-activities are measured in a methane counter with plates of dia up to 20 cm. Such a counter can also be used to measure as little as 3×10^{-12} curie of ^{131}I in 10 ml of blood; higher levels of radioactivity in blood can be determined by γ-spectrometry. Feces can be examined directly for α- and β-activity with an end-window counter, and for γ-activity with a scintillation counter; the sample may first be concentrated by evaporation, drying and ashing. Air-borne dust is collected on filters or sedimentation plates, and individual radioisotopes are identified either by the addition of inactive carrier and chemical separation, or by pulse-height analysis. The alkaline-earth metals are precipitated from aqueous solution of the sample or from an acid solution of the ash and separated by treatment with fuming HNO_3 (on the basis of the different solubilities of the nitrates). After the separation of Sr from Y, the renewed formation of ^{90}Y is differentiated from ^{90}Sr. Cs is isolated as $Cs_3Bi_2I_9$, iodine is extracted into an organic solvent, then precipitated as AgI, and Ra is isolated by means of EDTA, with added Pb and Ba as carrier. (Anal. Abstr., 11: No. 10, Oct. 1964)

11000 RADIOCHEMICAL DETERMINATION OF PLUTONIUM-239 IN LOW-LEVEL ENVIRONMENTAL SAMPLES BY ELECTRODEPOSITION. Harry Levine and Anthony Lamanna (Radiochemistry Support Lab., Rockville, Md.). Health Phys., 11: 117-25(Feb. 1965).

Aqueous solutions of known plutonium content and a variety of environmental media to which a known amount of plutonium was added were assayed by a scheme of chemical analysis including electrodeposition of plutonium on stainless steel planchets for alpha counting. The method is particularly effective in the range of n-to-pC (10^{-9}–10^{-12} C) per mg to 10 g amounts of sample solids such as soil, silt, food ash, rain, etc. Depending on precision desired the samples are prepared for analysis by one of three general methods, wet combustion and acid leaching (HNO_3) of up to 10 g sample solids, sodium peroxide sintering of up to 0.5 g sample solids, or sodium carbonate fusion of up to 1 g sample solids. The solubilized plutonium as the chloride is reduced to the trivalent state, coprecipitated with lanthanum carrier as the fluoride, dissolved in acid aluminum nitrate and extracted with thenoyltrifluoracetone (TTA) for separation and removal of impurities and carrier. The plutonium is then back-extracted with strong acid, oxidized and electrodeposited on stainless steel for counting. The yield for these weightless samples is estimated at over 83 per cent for samples containing in the order of 1 to 10 pC of plutonium per sample and over 95 per cent for larger amounts of plutonium. (auth)

11001 A RADIOCHEMICAL METHOD FOR THE MICRODETERMINATION OF TANNINS. Tsu-sheng Ma and Mei-hui Yang. J. Chinese Chem. Soc. (Taiwan), 10: 86-91(Sept. 1963).

A simple and rapid procedure is described for determining 1 to 10 mg of tannin in microchemical studies of

medicinal plants based on the precipitation of tannin-uranium complex. A 5% uranyl nitrate reagent solution was used in the sample which contained 1 mg of tannin/ml. The β-activity of the precipitate obtained was measured with a model 49-12 counter made by Radiation Instrument Dev. Lab. This method was superior to procedures depending on gravimetry, titrimetry, colorimetry, or spectrophotometry. (OID)

11002 SENSITIVITY IMPROVEMENT IN ANALYTICAL APPLICATION OF BETA-RAY BACKSCATTERING. Shigemasa Enomoto (Government Industrial Research Inst., Nagoya, Japan) and Tsutomu Ito. Keisoku To Seigyo, 3: 332-7(May 1964). (In Japanese)

To improve the sensitivity in analytical applications of β backscattering, the scattering characteristics were investigated by use of a $^{90}Sr-^{90}Y$ β source and an anthracene scintillation spectrometer. The dependence of the scattering intensity on specimen atomic number is increased in proportion to the scattering angle and the observed scattering β energy. Three methods are proposed to selectively measure the high energy component for sensitivity improvement: pulse height analyzing method; spectroscopic method using magnetic field; and filter method. Sensitivity improvement was practically confirmed in such analytical works as determination of the components of a Cu–Sn alloy or a powder mixture of TiC–WC, the concentration of $BaCl_2$ in aqueous solution, and the thickness of a layer of Sn on Fe. (auth)

11003 ON TRACE ANALYTICAL PURITY CONTROL OF REACTOR WATERS. Franz A. Pohl (Allgemeine Elektricitäts-Gesellschaft, Frankfurt am Main). Mikrochim. Acta, No. 5-6, 855-63(1963). (In German)

A determination of total impurities, including Al, Pb, Cd, Fe, Er, Ga, In, Co, Ni, V, Bi, Zn, and Zr, to within 1 ppB is suggested for purity checks of reactor waters. An analytical procedure was developed that includes conversion of the impurities into ionic forms, complexation of the total impurities with an excess of EDTA, treatment of the excess EDTA with a measured amount of Cd ion, and finally estimation of the unbound portion of this excess Cd by polarography. The reasons for this choice of stepwise procedure are outlined. Detailed instructions for the preparation of reagents, sampling, and enrichment of the sample with special detail paid to a quartz vessel for evaporation of water in a closed system, preparation of residues for determination, polarographic estimation, preparation of Cd polarographic standard curves, and calculations are given. Statistical tests of the method were satisfying; for most elements variation for single determinations was between 5 and 10%. The sensitivity of the method depends on the sensitivity of the polarographic method for Cd; thus for a 100-ml sample about 2 ppB Fe can be determined. The time required for an analysis depends on the amount of water to be evaporated; a 5- to 10-ml sample requires about 30 min. A description of an automatic execution of the analysis is given, with an illustration of the apparatus developed in schematic format. (BBB)

11004 COMPLEX FORMATION AND VALENCY EFFECTS IN THE ANALYSIS OF THE RARE-EARTH ELEMENTS. S. Pajakoff (Technische Hochschule, Vienna). Monatsh. Chem., 94: 400-5(1963).

Procedures are described for the separation of rare-earths from other elements by treatment with gaseous Cl at 700 to 800°C, precipitation as oxalate, phosphate or 8-hydroxyquinolinate in the presence of EDTA or similar complexing reagent, and selective sequential precipitation as phosphate by reduction of the concentration of H_3PO_4. Cerium, Pr and Tb can be determined by oxidative fusion with KNO_3 and titration of the quadrivalent ion; Pr and Nd may be determined by measurement of the absorption spectra of their complex phosphates. (Anal. Abstr., 11: No. 9, Sept. 1964)

11005 COLOR REACTION OF URANIUM WITH OMEGA CHROME BLACK BLUE G. Shozo Shibata, Teiichi Matsumae, Yoshinobu Niimi, and Tsurumatsu Dono (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 11: 160-4(1962).

The stable violet 1:2 complex between U and Omega Chrome black blue G (C.I Mordant Black 38) is formed within ≃ 30 min in aqueous solution of pH 5 to 6. A linear relationship exists between the extinction at 595 mμ (absorption max.) and U concentration over the range 1 to 10 μg per ml. Citric acid, oxalic acid, Cu, Fe, Zn, Pb, Ni, and many other metallic elements interfere seriously. The complex shows stronger absorption in aqueous acetone media than in aqueous solution. (Anal. Abstr., 11: No. 18, Dec. 1964)

11006 ANALYTICAL APPLICATIONS OF BETA-RAY BACK-SCATTERING. II. IMPROVEMENT OF THE SENSITIVITY OF THE SPECTROSCOPIC METHOD WITH A MAGNETIC FIELD. Shigemasa Enomoto and Chizuo Mori (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 11: 176-81(1962).

The sensitivity of the β-ray back-scattering method for the analysis of binary alloys was improved several times by discriminating the back-scattered electrons in a magnetic field. The method was successfully applied to Cu–Sn and Sn–Pb alloys with a $^{90}Sr-^{90}Y$ source. (Anal. Abstr., 11: No. 12, Dec. 1964)

11007 QUANTITATIVE DETERMINATION OF IMPURITIES IN BERYLLIUM OXIDE BY ATOMCOUNTER. Kiyoshi Morita and Horoshi Sunahara (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 13: No. 4, 161-8(Apr. 1964). (In Japanese)

The amount of impurities in beryllium oxide, such as Si, Mg, Cr, Pb, Cu, Ca, Fe, Mn, Ni, and Al, was determined by a compact Atomcounter. The samples were prepared by mixing six parts of beryllium oxide with 3 parts of graphite and one part of barium hydroxide or gallium oxide as a carrier. An ignited arc was used for excitation and a slight amount of water was mixed with beryllium oxide to prevent scattering at the elctrode crater. The N.B.L. spectrographic beryllium oxide samples were used for the calibration curves. The coefficient of variation in this method was less than 12 percent. (auth)

11008 PRECISION MASS SPECTROMETRIC ISOTOPE DILUTION ANALYSIS. P. J. De Bievre and G. H. Debus (EURATOM, Geel, Belg.). Nucl. Instr. Methods, 32: 224-8 (Feb. 1965).

A treatment is made of the error propagation in mass spectrometric quantitative determinations by means of isotope dilution. Diagrams are given allowing a choice of optimal conditions. (auth)

11009 QUENCHING OF LUMINESCENCE OF EUROPIUM IN INTRA-COMPLEX COMPOUNDS IN THE PRESENCE OF OTHER RARE-EARTH ELEMENTS. N. S. Poluektov, L. I. Kononenko, R. A. Vitkun, and M. P. Nikonova. Opt. i Spektroskopiya, 17: 73-7(1964).

A study was made of the effect of extraneous rare earth elements on the glow intensity I_{Eu} of Eu in precipitates of mixed phenanthroline-atrphane and phenanthroline-tenoiltrifluoroacetone complexes. The experimental procedure is described. A correlation was established between $\log I_{Eu}$ and the difference between the energy of the triplet state of the molecule of the complex and the nearest lower energy level of the extraneous rare-earth ion. In benzene solutions of the same complexes, in which molecules of Eu compounds and other rare-earth element compounds enter separately, there is no effects of the rare-earth ions on I_{Eu}. Results indicate that the sensitivity of rare-earth element analysis methods based on the measurement of the fluorescence of precipitates of complex compounds depends on the extraneous rare-earth elements present. (auth)

11010 ON THE LUMINESCENCE OF RARE EARTH IONS IN NaCl CRYSTALS. A. V. Dolgopolova, L. V. Kovaleva, S. A. Sazonova, and B. S. Skorobogatov. Opt. i Spektroskopiya, 17: 141-3(1964).

Continuing earlier research on NaCl crystals activated with trivalent Sm ions (Opt. i spektr. N. 3, 538, 1964), the luminescence of Pr^{3+}, Tb^{3+}, Gd^{3+}, Nd^{3+}, and Yb^{2+} in NaCl crystals are reported along with the luminescence spectra for Pr^{3+} and Tb^{3+} at room and low temperatures, and the absorption spectra of Yb^{2+} in NaCl, KCl, and KBr. Possible

level transitions responsible for the most pronounced lines are indicated. (auth)

11011 INVESTIGATION OF THE PLUTONIUM SPECTRUM UNDER DIFFERENT CONDITIONS OF EXCITATION IN A HOLLOW CATHODE. L. A. Korostyleva. Opt. Spectry. (USSR) (English Transl.), 17: 255-7(Oct. 1964). Translated from Optika i Spektroskopiya, 17: 469-74(Oct. 1964).

The behavior of the spectrum of Pu excited in a hollow cathode under various conditions of discharge was investigated at 3900 to 6700 Å. It was established that, with increasing Ar or Kr pressure at 0.3 to 1.8 mm Hg, the intensity of the spark spectrum increases as compared to that of the arc spectrum. On the other hand, it was found that adding He to Ar or Kr leads to a decrease in the intensity of spark lines as compared to the arc lines; with increasing concentration of He the intensities of these lines decrease. The obtained properties were used for the separation of the spark and arc spectra by using the change in the intensity of lines with increasing pressure and concentration of He in the gas mixture. In this way 275 lines of Pu were investigated and successfully assigned to the Pu I or Pu II spectrum. (auth)

11012 THIN LAYER CHROMATOGRAPHY WITHOUT BINDER IN MEDICAL ANALYSIS. 6. RADIOMETRIC DETERMINATION OF STRYCHNINE AND BRUCINE IN GALEN PREPARATIONS. M. Sarsunova, J. Tolgyessy, and M. Hradil (Kreisgesundheitsinstitut, Bratislava). Pharmazie, 19: 336-7(May 1964). (In German)

The quantitative radiometric determination of strychnine and brucine separated on alumina plates without binder, eluted, and precipitated with ^{131}I is described. Between five and 30 mg alkaloid a linear relation between concentration and radioactivity exists. The plates were prepared in the usual fashion, and the chromatograms developed with ether/ethanol (95:5), dried at room temperature, sprayed with I_2 in $CHCl_3$, and the spots indicated. The I_2 was driven off at 105°C. The alumina of the spots was washed off with micropipets, and transferred quantitatively to a test tube. Acetic acid (2%, 5 ml) was added and the alkaloids converted to salts by heating; the alumina was removed by filtration, and the filtrate transferred to a 50 ml flask. The alumina and test tube were washed with 5 ml 2% acetic acid. The alkaloids were precipitated with 2.5 ml aqueous acidified ^{131}I solution on a glass surface with fine openings. The filter paper and the rest of the precipitate in the flask were washed with 3 ml distilled water. After drying, the activity of the precipitate was measured. (BBB)

11013 A SIMPLE METHOD OF DETECTING CESIUM^{137} IN TISSUES. Juliusz Derecki. Polski Przeglad Radiol. i Med. Nuklearnej, 28: 575-80(Nov.-Dec. 1964). (In Polish)

A quantitative method of detecting of ^{137}Cs in biologic material is described. The method is suitable for rapid mass estimations. Efficiency of the method depends on exactness and simpleness of the apparatus used. (auth)

11014 MASS SPECTROMETRIC ISOTOPIC ANALYSIS OF URANIUM. Kiro Zmbov ("Boris Kidrich" Inst. of Nuclear Sciences, Belgrade). Radioaktivni Izotopi i Zracenja, 5: 810-18(1963). (In Yugoslavian)

A survey is given of the methods utilized in mass spectrometric determination of U isotope abundances. The focusing properties of the sector magnetic field and factors influencing the resolving power of the mass spectrometer are discussed. Various types of ion sources are described: electron impact sources for gaseous and solid samples, and single-filament and triple-filament surface ionization sources. It is shown that use of graphite-coated W filaments in surface ionization sources improves the efficiency of U^+ ion emission. The temperature dependence of U^+, UO^+ and UO_2^+ ion intensities in triple-filament source are discussed. The factors affecting ionization efficiency are discussed; efficiency is enhanced by introducing freon-12 in the ion source. A double action of this gas is observed: the fluorination of the UO_2 sample, and the adsorption of the gas on the ionizing surface. An increase of the work function of 0.8 ev was observed. (auth)

11015 THE IDENTIFICATION OF TRACE QUANTITIES OF RADIOACTIVE IODINE COMPOUNDS BY GAS-CHROMATOGRAPHIC AND EFFUSION METHODS. A. E. J. Eggleton and D. H. F. Atkins (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Radiochim. Acta, 3: 151-8(Nov. 1964).

Methyl iodide was identified as the principal I_2 compound formed when carrier free amounts of ^{131}I were released in the gas-phase by the oxidation of $Na^{131}I$ and neutron irradiated U metal or by heating irradiated UO_2 in mixtures containing CO_2. Smaller quantities of higher alkyl iodides were also found in varying proportions and a more reactive compound or compounds, so far unidentified, in the case of $Na^{131}I$ oxidation. Analytical methods used included solvent extraction, molecular weight determination by an effusion method and a new method of precisely comparing gas chromatographic retention volumes. (auth)

11016 CONTRIBUTIONS TO THE SEPARATION OF YTTRIUM FROM LANTHANUM AND CERIUM. P. Spacu, Elena Antonescu, Maria Mavrodin, and Silvia Serban (Inst. of Chemistry, Bucharest). Rev. Chim., Acad. Rep. Populaire Roumaine, 8: 95-114(1963).

The preparation, properties, and results of spectrophotometric study of Y, ^{57}La, and Ce compounds with organic acids are described. On the basis of these studies a method for the separation of Y from La and Ce in the form of chloromandelates in the presence of amino acids was established. A gravimetric method for the determination of Y was also developed. (auth)

11017 DETERMINATION OF ^{90}Sr–^{90}Y WITH THENOYLTRIFLUOROACTONE IN BENZENE SOLUTION. Maria Regina Sales Grade (CEEN, Lisbon). Rev. Port. Quim. (Lisbon), 4: 97-100(Dec. 1962). (In Portuguese)

The extraction of ^{90}Y by o-thenoyltrifluoroacetone in benzene solution was studied in order to determine $^{90}Sr + {}^{90}Y$ in fallout-contaminated waters. A high and reproducible yield (94.3 ± 2.2) was obtained in a range of concentrations from 0.02 to 1.8 in maximum permissible concentrations units. (auth)

11018 SCANNER FOR RADIOACTIVE PAPER STRIPS AND PLATES. Yoh Imai (Hokkaido Univ., Sapporo). Seikagaku, 33: 30-1(Jan. 1963). (In Japanese)

A method is described for assembling inexpensively a continuous and automatic instrument for scanning radioactive material on a strip of chromatographic filter paper laid on a moving plate. The device consists of a gas flow detector (e.g., Nuclear Chicago's Model D47), a radiation counter (e.g., Nuclear Chicago's Model A1619 Labitron), and a graph-recorder (e.g., Houston Technical Lab.'s model). The main features of this device are use of a plate, not a paper strip to be rolled up, and the synchronization of the movement of the specimen plate and the graph-recorder by using a common axis powered by the latter. The filter paper or glass plate is glued to a long stainless-steel strip which slides back and forth through a slot under the fixed gas-flow detector. The sliding motion is provided by a gear which moves the teeth cut in the lower edge of a metal strip attached perpendicularly to the lower surface of the plate. The gas-flow detector with its support is sealed, except for the sliding slot, to prevent gas leakage. The gap between the specimen and the detector can be made adjustable to keep it minimal. The device thus assembled is not only a sensitive instrument but also a much less expensive one than those presently available on the market. Furthermore, it is free of the danger of contamination by radioactive specimens when the strip is rolled into it, as in the conventional instrument. It also permits re-use of the specimen for other purposes. (BBB)

11019 ANALYSIS OF REFRACTORY MATERIALS CONTAINING ZIRCONIUM DIOXIDE. J. Váchová and M. Paleček (Ploche Sklo, Retenice, Czechoslovakia). Sklar Keram., 13: No. 7 Add., 73-8(1963).

After decomposition of the sample and determination of SiO_2, the cations to be determined are adsorbed on Zerolit 225 cation-exchange resin, then eluted with 2N-HCl (for Al, Fe, Ti, Ca) and with 5N-HCl (for Zr). The eluates are ana-

lyzed colorimetrically (e.g., for Fe with 2,2′-bipyridyl, and for Ti with H_2O_2) or by EDTA titration (for Al, Ca and Zr). (Anal. Abstr., 11: No. 10, Oct. 1964)

11020 ERIOCHROME BLUE S.E. AS REDOX INDICATOR. E. Banyai, L. Erdey, and K. Kolos (Technical Univ., Budapest). Talanta, 12: 21-5(Jan. 1965). (In German)

Eriochrome Blue S.E. can be used as a redox indicator for titrations with cerium(IV) sulfate and potassium bromate standard solutions in acidic medium, and for titrations with sodium hypobromite standard solution in alkaline medium. The color change is sharp both in 0.1 and 0.01N titrations, and the indicator error is negligible. The standard redox potential of the indicator is +0.87 v (against H_2). When oxidized with cerium(IV) ions, presumably an azoxy-product is formed reversibly. (auth)

11021 A QUALITATIVE SEPARATION PROCEDURE FOR URANIUM FISSION PRODUCTS OF MEDIUM OR LONG HALF LIVES WITH THE HELP OF THE RING OVEN METHOD. H. Weisz and D. Klockow (Universitat, Freiburg i. B.). Talanta, 12: 55-67(Jan. 1965). (In German)

A qualitative separation procedure for uranium fission products of medium or long half lives (isotopes of Cs, I, Sr, Ba, Zr, Nb, Ru, Y, and rare earths) in a drop of solution, using the ring oven, is described. The test drop containing the radionuclides and submicrogram amounts of the corresponding carriers is spotted on a filter paper. Precipitation, dissolution, demasking, and washing procedures are applied to wash out single isotopes or groups of isotopes from the central spot and concentrate them in different ring zones. The identification of the nuclides or groups of nuclides is by autoradiography of the individual rings. The yields of the various separation steps are tabulated. The interpretation of the autoradiographs and possible uses of the separation are discussed. (auth)

11022 A NEW METHOD FOR THE GRAVIMETRIC DETERMINATION OF URANIUM. Raluca Ripan and V. Sacelean (Universite Babes-Bolyai, Cluj). Talanta, 12: 69-72 (Jan. 1965). (In French)

A method for the gravimetric determination of uranium is based on the precipitation of the UO_2^{2+} ion, in the pH range 3–5, by a solution of p-aminobenzoic acid and pyridine in water. An amorphous yellow precipitate forms, which is easily filtered and has the composition $UO_2(H_2N-C_6H_4-COO)_2 \cdot 2Py \cdot 2H_2O$. This is ignited to U_3O_8. Comparative determinations with ammonia and with oxine indicate that the new method is superior to these. Certain ions that interfere with the determination can be masked with Complexone-II dissolved in pyridine-water. (auth)

11023 ACTIVATION ANALYSIS DETERMINATION OF MOLYBDENUM IN TUNGSTEN. H. Grosse-Ruyken and H.-G. Doege (Technische Universitat, Dresden). Talanta, 12: 78-80(Jan. 1965). (In German)

A method for the determination of traces of molybdenum in tungsten by activation analysis is described. The determination is done by measuring the activity of technetium-99m, daughter of molybdenum-99. Radiochemically pure technetium is separated from other radionuclides by pyridine extraction and anion-exchange chromatography. Amounts of 10^{-8}g of molybdenum can be determined. (auth)

11024 ON THE SYNTHESIS OF POLYMERIZED ALLYLTRIPHOSPHATE AND ITS USE FOR THE ION-EXCHANGE SEPARATIONS OF SEVERAL RADIOACTIVE NUCLIDES. Mutsuaki Shinagawa (Osaka Univ.) and Toshiaki Okada. Technol. Rept. Osaka Univ., 14: 681-6(Mar. 1964).

Allyltriphosphate was synthesized from silver triphosphate and allyl alcohol. The H-form polymer showed analogous behavior with sodium triphosphoric acid when titrated with sodium hydroxide solution and had five dissociation stages of which pK_4 and pK_5 were estimated to be 4.3 and 11.3, respectively. The ion-exchange capacity of the resin was estimated by several methods and found to be 3.89 mequiv/g up to the fourth stage of the dissociation. By use of the Na-form condensate as an ion-exchanger, ^{90}Sr- ^{90}Y, ^{90}Sr- ^{90}Y- ^{137}Cs, and ^{144}Ce- ^{144}Pr were successfully separated. The elution curves showing the relation of β activity and flow of effluent were obtained. (auth)

11025 SEPARATE SPECTROPHOTOMETRIC DETERMINATION OF ELEMENTS OF THE RARE-EARTH GROUP. II. DETERMINATION OF PRASEODYMIUM, NEODYMIUM, HOLMIUM, ERBIUM AND THULIUM IN CONCENTRATES WITHOUT PRELIMINARY SEPARATION OF TOTAL RARE-EARTH ELEMENTS. D. P. Shcherbov and V. A. Mirkin. Tr. Kazakhsk. Nauchn. Issled. Inst. Mineral'n. Syr'ya, No. 7, 194-9(1962).

The determination of 0.2 to 0.5% of the elements named in concentrates is based on measurement of the absorption spectra of their ions in the visible region. Procedure — Decompose the sample (1 to 2 g) in a Pt dish with HF (10 ml) and H_2SO_4 (2 ml), evaporate to fumes, add more HF (8 ml), and again heat to fumes. Add H_2SO_4 (10 ml) to the residue, evaporate almost to dryness, and treat the residue with HCl (1:4) (5 ml). Transfer the solution and residue to a glass beaker, wash out the dish with HCl (5 ml), set aside the beaker on an ice bath for 3 hr, stirring every 5 to 10 min, filter, and wash the filter with HCl (3 × 1 ml). To the filtrate add 2 ml of a 40% solution of $SnCl_2$ in HCl (1:1), dilute to 15 ml, and record the absorption spectrum, with 5-cm cells; as a comparison solution use a mixture of 1 ml of H_2SO_4, 12 ml of HCl (1:4) and 2 ml of the 40% $SnCl_2$. Construct a calibration graph with standard solution of the rare-earth elements (10 mg of sesquioxide per ml) in 1-, 2-, 3-, and 5-cm cells. The height of the characteristic absorption peak with a 1-cm depth of solution corresponds to an absolute amount of the given rare-earth element of 30 mg; the height of the peak with a 2-cm depth corresponds to 60 mg of the element, and so on. The results of the spectrophotometric determinations are similar to those of chromatographic and x-ray-spectrographic determinations. With a 1-g sample, the method can be used to determine ≤0.1% of Pr, ≤0.20% of Nd, ≤0.30% of Ho, and ≤0.5% of Er and Tm. (Anal. Abstr., 11: No. 9, 1964)

11026 SEPARATE SPECTROPHOTOMETRIC DETERMINATION OF ELEMENTS OF THE RARE-EARTH GROUP. III. ABSORPTION SPECTRA OF SOLUTIONS OF SOME COMPLEX IONS CONTAINING RARE-EARTH ELEMENTS. D. P. Shcherbov and V. A. Mirkin. Tr. Kazakhsk. Nauchn. Issled. Inst. Mineral'n. Syr'ya, No. 7, 200-3(1962).

The influence of certain complexing agents on the sensitivity and selectivity of the determination of the rare-earth elements when present together was studied. In the presence of EDTA, all the maxima on the absorption curves of Pr, Nd, and Tm are displaced towards longer wavelengths, some of the peaks found with Ho and Er are displaced towards shorter wavelengths, but with Sm there is no marked shift of the maxima. The presence of citrates has no effect on the positions of the peaks due to Pr, but the Nd peak is shifted towards longer wavelengths and overlaps with a Pr peak. The binding of Pr, Nd, Tm, Ho, Er, and Sm with EDTA or citrate has practically no effect on the sensitivity of the determination, but considerably diminishes its selectivity. (Anal. Abstr., 11: No. 9, Sept. 1964)

11027 DETERMINATION OF PRASEODYMIUM, NEODYMIUM AND SAMARIUM BY MEANS OF ABSORPTION SPECTRA OF THEIR DICHLOROOXINATES. M. I. Gromova, T. E. Romantseva, and V. M. Peshkova. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 57-61(July-Aug. 1964). (In Russian)

The molar absorption coefficient of Nd was increased 10-fold by complexing it with dichlorooxine. As a result, Nd could be determined in amounts of 0.1 mg in mixtures with Pr and Sm. The mixtures were extracted by chloroform at pH 9.2 to 9.7, and from the absorption at 581 and 640 mμ for Nd-Pr mixtures and at 581 and 1085 mμ for Nd-Sm mixtures, the amounts present were determined. (IIC-M.G.)

11028 DETERMINATION OF THE HARDNESS OF WATER BY THE ISOTOPE DILUTION METHOD. Junichi Takanaka (Hiroshima Univ.) and Yoshiko Minogami. Yosui To Haisui, 6: 389-92(May 1964). (In Japanese)

The determination of calcium (hardness of water) in

water by the isotope dilution method is described. Using this method, it is not necessary to have a complete precipitation of calcium oxalate. The method is as follows: 1.495 g of $CaCl_2 \cdot 2H_2O$ is dissolved in water to obtain 2053 ppm of Ca. 0.5 mC of ^{45}Ca is dissolved in 1N−HCl to have standard $^{45}CaCl_2$ solution; 0.5 ml of standard calcium chloride is taken to form standard calcium oxalate with 5 ml (0.05 m/l) ammonium oxalate, the precipitate formed is collected; and the weight and radioactivity is then measured. The specific radioactivity is defined as the radioactivity (total) divided by its weight. The amount of calcium in the water, W_x, is calculated as follows; $W_x = (S_1/S_2 - 1)W_1$ where W_1 is 29.9 mg/10 ml, S_1 is the specific radioactivity of the standard calcium oxalate, and S_2 is the specific radioactivity of the calcium oxalate obtained from the test solution. If the amount of calcium is large, the method is readily applicable; but it becomes somewhat difficult if the amount of calcium in the water is less than 150 ppm. The half life of ^{45}Ca is only half a year, and so care must be taken in preparation of the standard solution. (NSA of Japan)

11029 DETERMINATION OF TRACES OF URANIUM IN WATER. E. Singer and J. Mareček (Research Inst. for Inorganic Chemistry, Usti nad Labem, Czechoslovakia). Z. Anal. Chem., 196: 321-3(1963). (In German)

After precipitation of U with $Al(OH)_3$, U^{6+} is reduced to U^{4+}, and U is determined spectrophotometrically, at 665 mμ, with arsenazo III. As little as 1 μg of U/l can be determined; the coefficient of variation being 5%. (Anal. Abstr., 11: No. 8, Aug. 1964)

11030 ON THE RAPID DETERMINATION OF METAL TRACES IN REACTOR WATERS. Franz A. Pohl (Algemeine Elektricitäts-Gesellschaft, Frankfurt am Main). Z. Anal. Chem., 197: 193-7(1963). (In German)

A method, previously lacking, for the determination of ppB of metal ions in water in a continuous program was developed in which an integrating determination is made. However the method turned out to be unsuccessful. The reasons for failure are discussed. Finally a polarographic method of estimation was chosen; the EDTA complex of Cd was found to be reducible at a very negative potential, where it does not decompose, and thus Cd was chosen as metal B. A short discussion of a possible procedure for use in reactor waters includes an outline of the procedure, utility for control of water purity and changes in the purity, the sensitivity of the method, and a suggestion for complete automatization of the process. It should be possible to have analyses requiring 30 min, giving a reading every 10 min on a sample taken 30 min previously. (TCO)

11031 SPECTROCHEMICAL DETERMINATION OF TRACES OF TITANIUM, ZIRCONIUM, HAFNIUM AND THORIUM IN SOLUTIONS. T. M. Moroshkina and M. N. Smirnova (Leningrad State Univ.). Zh. Analit. Khim., 19: 1519-21(1964). (In Russian)

A method was developed for the spectrochemical determination of traces of titanium, zirconium, hafnium, and thorium in solutions. Extraction and ion exchange chromatography were used for trace concentration. The sensitivity of the method is down to 5 μg of elements in a sample or 0.0005 μg/ml. The mean experimental error of a single determination is ±8 to 9%. (auth)

11032 THE DEVELOPMENT AND APPLICATION OF AN IMPROVED RADIOMETRIC TECHNIQUE FOR ISOTOPE DILUTION ANALYSIS—ILLUSTRATED BY THE DETERMINATION OF PHOSPHORUS IN ROCK PHOSPHATES. J. Rijkheer and S. Bozalek (African Explosives and Chemical Industries Ltd., North Rand). p.72-82 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Theoretical and practical considerations involved in the isotope dilution method are briefly reviewed and the development of equipment and a procedure to minimize errors commonly arising in its application are described. It is shown that the technique developed is capable of giving accurate results of very high precision by normal analytical standards. The application of the technique to the determination of the true phosphorus contents of three different types of rock phosphate is described. The coefficient of variation of the results obtained in seven replications was found to vary from 0.04 to 0.12. (auth)

11033 ENRICHMENT AND ASSAY OF NATURALLY OCCURRING TRITIUM. B. Th. Verhagen and J. P. F. Sellschop (Univ. of Witwatersrand, Johannesburg). p.109-19 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

The major problems associated with the measurement of naturally occurring tritium are considered. The potency of assay by a combination of thermal diffusion enrichment and gas counting is argued. Parameters of and experiments on a two-stage thermal diffusion system are described and results presented. (auth)

11034 A SIMPLE TECHNIQUE FOR THE DETERMINATION OF LABELED FERTILIZER PHOSPHORUS CONTENT OF GROWING PLANTS. J. N. Marais and A. J. Ohlrogge (Purdue Univ., Lafayette, Ind.). p.397-402 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

A method for determining the ^{32}P-labeled phosphorus content without harvesting the plants was developed and tested. The labeled phosphorus content of soybeans was determined by measuring plant activity with a battery of Geiger-Müller tubes maintained in a constant position. Activity corrected for coincidence and decay correlated highly (R = 0.96) with the labeled phosphorus content of plants during all stages of growth. This method eliminated the need for corrections for variation in plant height with time. (auth)

11035 DETERMINATION OF THE AGE OF WHITE LEAD BY NEUTRON ACTIVATION—POSSIBLE APPLICATION TO PAINTINGS. J. P. W. Houtman and J. Turkstra (Reactor Institute, Delft, Holland). p.588-93 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

The methods of purification of lead have changed and improved over the centuries, and the white lead at present available as a pigment and as a primer on paintings is likely to have smaller amounts of trace impurities than that of older origin. By submitting samples of white lead from various sources and ages to neutron activation analysis, a clear indication can be obtained as to the period of manufacture of the sample and thus the age of paintings. Silver, Hg, and Zn in white lead used for painting were quantitatively determined by neutron activation followed by solvent extraction and γ spectroscopy. (P.C.H.)

11036 POWERFUL NUCLEAR TECHNIQUES FOR UNIVERSAL USE. Paul C. Aebersold (Atomic Energy Commission, Washington, D. C.). p.600-23 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Well established qualitative and quantitative nuclear analytical techniques involving the emission, scattering, absorption, and capture of nuclear radiations of various types are described. Neutron activation analysis and various forms of radiometric analysis are reviewed in particular. Other techniques are touched upon where new developments appear to be of special interest. The rapid development, which radioactivation analysis, special radiometric and radioisotope-release procedures are now undergoing, is outlined. New techniques based on other nuclear and nuclear-related principles remain to be developed. (auth)

11037 ANALYTICAL METHODS FOR TESTING REACTOR-PURE URANIUM. J. Minczewski. p.69-80 of "Reinststoffe in Wissenschaft und Technik." Berlin, Akademie-Verlag, 1963.

A state-of-the-art review of emission spectroscopy (carrier distillation method), flame photometry, colorimetry, polarography, and ion exchange methods for trace analysis of U is presented. A sensitivity up to 10^{-6}% for determination of B, Cd, Li, Hg, Ir, Sm, Eu, Gd, and Dy, up to 10^{-4}% for Sc, Mn, Co, Tc, Rh, Ag, In, Cs, Hf, Ta, W, Re, Pt, Au, Pr, Nd, Tb, Ho, Er, Tu, Yb, and Lu, and from 10^{-4} to

10^{-2}% for K, Ti, V, Fe, Ni, Cu, Ga, As, Y, Nb, Mo, Ru, Pd, Sb, La, Os, and Tl is required. In addition, all these traces must be determined in the main component of the sample, i.e. in the uranium. Comparison of these methods shows that the spectrochemical methods are more advantageous for series analyses, sample preparation and excitation are easily performed in closed systems avoiding additional atmospheric pollution of the samples, and reagents consumption is very low. The advantage of all other methods lies in the simple and sure preparation of standard samples in the form of solutions. (auth)

11038 ATLAS AND TABLES FOR EMISSION SPECTROGRAPHIC ANALYSIS OF RARE EARTH ELEMENTS. Ch. Kerekes. New York, The Macmillan Company, 1964.

The data and information are presented to aid in analyzing rare earths using a Zeiss Q 24 spectrograph or with instruments of similar dispersion. Use of the Atlas allows identification of the most sensitive rare earth analysis lines. The wavelength values of the analysis lines are included along with wavelengths and relative intensities of interfering spectral lines belonging to other rare earths and Sc and Y. (J.R.D.)

11039 PROCEDURES FOR DETERMINATION OF STABLE ELEMENTS AND RADIONUCLIDES IN ENVIRONMENTAL SAMPLES. C. R. Porter, R. J. Augustine, J. M. Matusek, Jr., and M. W. Carter, eds. (Public Health Service, Washington, D. C.). Public Health Service Publication No. 999-RH-10. Jan. 1965. 83p. (Free from USPHS).

A manual is presented of methods used at the Public Health Service's Southeastern Radiological Health Laboratory for the determination of stable elements and radionuclides in environmental samples. The procedures are intended for use in the processing of relatively large numbers of samples in a minimum of time for environmental radiological surveillance. The manual is divided into sections on: milk; food, biota, silt, and soil; water; and counting procedures. Appendixes cover preparation of reagents and tables of selected radionuclide decay and in-growth factors. (auth)

11040 NEUTRON IRRADIATION AND ACTIVATION ANALYSIS. Denis Taylor. Princeton, N. J., D. Van Nostrand Co., Inc., 1964. 185p.

Principles and applications of activation analysis are discussed. Topics covered include: neutron interactions, detection of prompt radiation, neutron activation analysis, applications, automation of techniques, analysis of process streams, activation analysis in prospecting and possibilities for future applications. Examples are given to illustrate the main measuring techniques used. (M.C.G.)

11041 DEVELOPMENTS IN APPLIED SPECTROSCOPY. VOLUME 3. J. E. Forrette and E. Lanterman, eds. Proceedings of the Fourteenth Annual Mid-America Spectroscopy Symposium held in Chicago, Illinois, May 20-23, 1963. New York, Plenum Press, 1964. 415p. $17.50. (CONF-630501)

Thirty-two papers presented at the Fourteenth Annual Mid-America Spectroscopy Symposium are included. Topics covered include: x-ray spectroscopy, infrared-Raman spectroscopy, emission spectrography, nuclear magnetic resonance and electron spin resonance, ultraviolet spectroscopy, and gas chromatography. (M.C.G.)

11042 SOME OBSERVATIONS ON X-RAY EMISSION AS A FUNCTION OF ACCELERATING VOLTAGE IN THE MICROPROBE. D. L. Burk (Allegheny Ludlum Steel Corp., Brackenridge, Penna.). 30p. (CONF-715-7)

From 13th Annual Conference on Applications of X-ray Analysis, Denver, Aug. 1964.

Data are presented from several systems for which the emitted x-ray intensity goes through a maximum as accelerating voltage is increased. An attempt is made to systematize the data in terms of absorption, wavelength, and atomic number. A very simple model, analyzed graphically, is capable of displaying many of the features of the experimental data. An understanding of the dependence of x-ray output upon accelerating voltage is crucial to the development of quantitative microprobe analysis. (auth)

11043 MAGNETIC SECTOR FIELD FOR THE SEPARATION OF IONIZED PARTICLES IN A MASS SPECTROMETER. Henri Bruck (Commissariat a l'Energie Atomique). German Patent 1,175,465. Aug. 6, 1964. Priority date Sept. 15, 1955, France.

A mass spectrometer is described in which the magnetic core is subdivided in sectors. The pole faces of the magnet sectors facing the toroidal separation chamber are either convergent or divergent with respect to the center (alternating gradient of the magnetic field). At the beginning and at the end of the particle paths there are sectors of the converging type. By this arrangement the resolution of the spectrometer is essentially improved without enlarging the dimensions. (Gmelin Inst.)

11044 FLOW COUNTER FOR THE MEASUREMENT OF TRITIUM. Hermann Kimmel (to Gesellschaft fur Kernforschung mbH). German Patent 1,180,856. Nov. 5, 1964. Filed Oct. 21, 1961.

The counter walls and the electrodes, which are in contact with the counter gas, are heated in such way that they have a higher temperature than the tritium and the filling gas. By this means condensation from the counter gas and therefore contamination of the counter is avoided. (Gmelin Inst.)

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Refer also to abstracts 11354 and 11668.

11045 (ANL-6951) EVALUATION OF PHYSICAL PROPERTIES OF GASES AND MULTICOMPONENT GAS MIXTURES. John T. Holmes and Manfred G. Baerns (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 23p. Dep.; $2.00(OTS).

Relationships which can be used to estimate the density, heat capacity, viscosity, thermal conductivity, and diffusivity of gases and multicomponent gas mixtures are presented and reviewed. These relationships were incorporated into a computer program for calculation and compilation of the properties for the desired components and mixtures at temperatures and pressures specified by the user. The calculations are made either by extrapolation of experimental data given at conditions other than those desired or by using the critical and molecular properties of the gases. The computer program was used to solve a sample problem dealing with the physical properties of CO_2, O_2, and N_2 mixtures. (auth)

11046 (AROD-2099:22) RARE EARTH IONS IN CRYSTALLINE FIELDS. Final Technical Report. Robert A. Satten (California. Univ., [Berkeley]). Nov. 30, 1964. Contracts DA-04-495-ORD-1375 and DA-ARO(D)-31-124-G75. 17p.

A summary of results and conclusions from studies of lanthanide and actinide ions in crystalline fields is presented. A bibliography of references in which the results and conclusions appear is included. (J.R.D.)

11047 (CEA-R-2566) ETUDE ELECTRO-CHIMIQUE DANS LE TCHIOCYANATE DE POTASSIUM FONDU. (Electrochemical Study in Molten Potassium Thiocyanate). Gisèle Metzger (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay). Oct. 1964. 52p. Dep.(mn).

A study was made of the electrochemical properties of molten potassium thiocyanate at 195°C. The molten salt is dissociated into K^+ and CNS^- ions; since the K^+ ions are very difficult to reduce it is the oxido-reduction reaction of the SCN^- ion which limits the electro-active zone of the solvent. It is shown that SCN^- behaves as an addition compound of S^0 and CN^-; analysis of the products formed during the oxidation and the coulometric reduction of the bath shows that the electrochemical reactions which limit the electro-active zone of the solvent are the following: $SCN^- + 2e \rightarrow S^{2-} + CN^-$ and $SCN^- + 2e \rightarrow S + \frac{1}{2}(CN)_2^-$. It is possible also to carry out the chemical oxi-

dation of the thiocyanate by introducing an oxidizing cation such as Fe^{3+} or Cu^{2+}. This reaction leads to the same chemical species as the electrochemical oxidation. With respect to the $Ag|/Ag^{+}$ 0.1 M electrode taken as reference, the electro-active limits are from −1.050 v to +0.750 v for a platinum electrode, and from −1.350 v to +0.050 v for a mercury drop electrode. The electrochemical behavior of a certain number of ions in the molten salt was also studied; by plotting the intensity-potential curves it has been possible to determine the half-wave potentials of several cations: Pb^{2+}, Sn^{2+}, Fe^{2+}, Cd^{2+}, Zn^{2+}, Hg_2^{2+}, Hg^{2+}, Cu^{+}, Co^{2+}, Ni^{2+}, Cr^{3+}. A comparison of the potential values found in the thiocyanate with those which are already known for other molten solvents made it possible for one to find parallels between the properties of the thiocyanate and those of certain salts such as molten chlorides or nitrates. Thus the complexing properties of SCN^{-} with respect to Cu^{+} underline the oxidizing properties of Cu^{2+}. A polarographic study of complexes in molten salts showed the existence of two cupro-cyanic complexes having the formulas $Cu(CN)_2^{-}$ and $Cu(CN)_4^{3-}$, of which the dissociation constants were measured experimentally. (auth)

11048 (IA-1004) ACTIVITY COEFFICIENTS OF VARIOUS ELECTROLYTES. MOLAL AND MOLAR CONCENTRATIONS. M. Gazith, comp. (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Oct. 1964. 46p. Dep.(mn).

Molal and molar concentrations were calculated by a numerical method for round values up to very high concentrations for 33 electrolytes, acids, bases, and salts. The concentration values are tabulated together with molal activity coefficients, at 25°C, fitted graphically for each concentration. (auth)

11049 (K-1466) DENSITY OF LIQUID URANIUM HEXAFLUORIDE. R. J. Wertz and W. D. Hedge (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 1, 1965. Contract W-7405-eng-26. 17p. Dep.; $1.00(OTS

The density of pure uranium hexafluoride was determined over the temperature range 65 to 90°C using a nickel pycnometer. From these data, pooled with those of other investigators, the density of natural uranium hexafluoride over the liquid range is expressed by the equation $\rho = 2.0843 - 0.0031t + 0.3710\ (230.2 - t)^{0.3045}$, where ρ is the density in grams per cubic centimeter and t is the temperature in degrees centigrade. The densities of several uranium hexafluorides of altered isotopic abundance, measured relative to the density of natural uranium hexafluoride, vary directly as the molecular weight. (auth)

11050 (MCW-1490) SOLUBILITY OF UO_2 IN MOLTEN SALT. J. W. Varwig (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Nov. 25, 1964. Contract W-14-108-eng-8. 25p. Dep.; $2.00(OTS).

The solubility of UO_2 in several metal fluoride salt mixtures was measured. The UO_2 solubility is a function of UF_4 content of the melt varying from ~0.1 wt % UO_2 at 0 wt % UF_4 in the melt to ~2.3 wt % UO_2 at 45 wt % UF_4. The diluent salt mixtures (represented as mole ratios of salt A to salt B) LiF : BaF_2, 4LiF : BaF_2, MgF_2 : BaF_2, LiF : YF_3, and LiF : BaF_2 plus 9 wt % ThF_4 all gave similar UO_2 solubilities. Diluent salt LiF : CeF_3 gave a higher solubility and LiF : SrF_2 gave a lower solubility. (auth)

11051 (SC-DC-64-1432) BERYLLIUM STUDY PROGRAM. Quarterly Progress Report No. 3, April 1–June 30, 1964. J. L. Blumenthal and Myrrl Santy (Thompson Ramo Wooldridge Inc. TRW Space Technology Labs., Redondo Beach, Calif.). July 20, 1964. For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 69p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The reaction kinetics studies were continued and investigations of the reactions of beryllium with nitric oxide, water vapor, moist oxygen, and carbon dioxide were carried out. A few additional experiments were also run on the previously studied beryllium-oxygen and beryllium-nitrogen reactions. The experiments were conducted in the temperature range from 900 to 1500°C and over the pressure range from 1 mm Hg to 1 atm. The experimental results indicated the following: (1) Dry nitric oxide at 1500°C is about 3.5 times less reactive than nitrogen and about fifty times less reactive than oxygen with beryllium. (2) The reaction of carbon dioxide with beryllium is similar to the beryllium-carbon monoxide reaction. (3) The beryllium-oxygen reaction rate in the temperature range from 1050 to 1200°C is several hundred times faster at atmospheric pressure than it is at 1 mm Hg pressure. (4) There is some evidence that water vapor may be even more reactive with beryllium than oxygen. Microscopic studies of the combustion products formed from beryllium reactions with oxygen, water vapor, and carbon dioxide indicate that in all three cases some reaction products in the airborne particle size range were formed. Preliminary experimentation, calibration, and checkout of the high temperature tank facility has been initiated. (auth)

11052 (SRIA-135) SORPTION OF GASES ON METAL SURFACES IN ULTRAHIGH VACUUM. Quarterly Progress Report No. 9, August 15–November 15, 1964. B. Bergsnov-Hansen, N. Endow, and R. A. Pasternak (Stanford Research Inst., Menlo Park, Calif.). Dec. 14, 1964. Contract AT(04-3)-425. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Data are presented on the sorption of N_2 and Xe on Mo films at −195 and −185°C. In the investigation of the H-D exchange reaction, residual gases and residual exchange in the flow system were studied, and steady-state exchange measurements over a wide range of temperature and pressure are reported. The CO production by several bare and coated ion-gage filaments in the absence and presence of H_2 was studied. (D.L.C.)

11053 (TID-21610) THE STUDY OF URANYL NITRATE-UREA COMPLEXES PREPARED BY SOLID-SOLID INTERACTION AND FROM SOLUTION (thesis). Louis S. Campisi (Fordham Univ., New York). 1965. Contract AT(30-1)-906. 90p. Dep.(mn); $3.00(cy), (2(mn) OTS.

Utilizing a solid-solid interaction, $[UO_2(NO_3)(Urea)_3](NO_3)$, $[UO_2(Urea)_5](NO_3)_2$, and α- and β-$[UO_2(NO_3)_2(Urea)_2]$ were prepared for the first time. These compounds were also isolated from solution, in addition to $[UO_2(Urea)_4(NO_3)(H_2O)]NO_3$, $UO_2(NO_3)_2 \cdot 4Urea \cdot 2H_2O$, and $UO_2(NO_3)_2 \cdot 2C_2H_5OH$. The absence of an anhydrous tetrakis(urea) uranyl nitrate complex has been noted, dehydration of $[UO_2(NO_3)(Urea)_4(H_2O)](NO_3)$ leading to a mixture of $[UO_2(NO_3)(Urea)_3](NO_3)$ and $[UO_2(Urea)_5](NO_3)_2$. The deleterious influence of KBr on the infrared spectra of uranyl nitrato complexes is reported. Infrared studies on all of the complexes indicate that the ligand, urea, is bound through the carbonyl oxygen to the uranyl ion. For the series of complexes prepared, infrared data were interpreted with regard to nitrate and nitrato groups. It was found that nitrato coordination decreases as the number of other ligands (urea) increases. An explanation for the formation and stability of $[UO_2(NO_3)_2(Urea)_2]$ in ethanol and the tetrakis(urea) complex in water, has been offered. (auth)

11054 (TID-21615) TECHNICAL PROGRESS REPORT [ON FUSED SALT SYSTEMS]. (Temple Univ., Philadelphia). Jan. 1965. Contract AT(30-1)-2780. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A characterization was made of the dark blue precipitate which forms in cobalt solutions in $LiNO_3$–KNO_3 eutectic below 180°C when KCl is added. Chemical analyses, spectra, magnetic measurements and x-ray diffraction show that the precipitate is a compound $K_4CoCl_4(NO_3)_2$ and that cobalt in this compound is eight coordinated. A study was made of the experimental parameters involved in the abnormal conductivity results obtained when large and small vessels are used. It is concluded that, for KCl in $LiNO_3$–KNO_3 eutetic, noticeable wall conduction can occur using a large pyrex glass vessel and a single capillary electrode. (D.L.C.)

11055 (UJV-1139/64) SOME NOTES TO THE EXCHANGE OF IONS ON AMMONIUM SALTS OF HETEROPOLY ACIDS. J. Krtil (Československá Akademie Věd. Ustav Jaderného Výzkumu, Řež). [1964]. 7p. Dep.(mn).

The ion exchange properties of ammonium phosphomolybdate and phosphotungstate for heavy alkali ions and multivalent ions are discussed. Some experiments on the sorption of Y and Ce on these two salts are described in which the log K_d-log H plot have a slope of 3. The disagreement of the results with these of Smit and Robb is discussed. It is concluded that one Sr^{2+} exchanges for $2H^+$ ions and one Ce^{3+} or Y^{3+} exchanges for $3H^+$ ions. (D.L.C.)

11056 (AEC-tr-6227/3(p.183-92)) STABILITY CONSTANTS OF METAL COMPLEXES WITH 2-METHYLHEPTANE-4, 6-DIONE AND HEXANE-2, 4-DIONE. D. B. Stevančević and V. G. Antonijević. Translated from Bilten Inst. Nukl. Nauke "Boris Kidric," 15: 183-92 (1964).

Dissociation constants of diketones and stability constants of complexes of metals with diketones were determined by pH-metric titration in a water–50 vol % dioxane solution. Van Uitert's method was used to determine the thermodynamic constants in this medium. (auth)

11057 THE INFRARED SPECTRA OF THORIUM COMPLEXES. I. THORIUM-THIOSALICYLATE, p-AMINOSALICYLATE, AND MERCAPTOBENZOTHIAZOLATE. I. Galateanu (Institutul de Fizica Atomica, Academiei R.P.R., Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Chim., 11: 239-46(1963). (In Romanian)

Thorium thiosalicylate was formed by adding 15 ml of a 0.5M solution of thiosalicylic acid (in 0.1N NaOH) to 25 ml of 0.02M Th nitrate solution (pH 1.6). Thorium thiosalicylate is precipitated at the resulting pH of 4 to 4.5. Elementary analysis confirmed the composition $Th_2(OH)_2(SC_6H_4COO)_3 \cdot H_2O$. p-Aminosalicylic acid was used to prepare the corresponding Th complex by a previously described method, and the procedure for precipitation of Th mercaptobenzothiazolate was also published earlier. Infrared spectra were obtained for these complexes with NaCl crystals, at 600 to 1700 cm^{-1} and LiF crystals, at 2400 to 3800 cm^{-1}. The infrared spectra of the Th complexes with thiosalicylic and p-aminosalicylic acids show that in complexing Th with these acids, carboxylic groups, thio groups, and amino groups participate. It was shown that mercaptobenzothiazole in the thioamine form does not react with Th. The presence in these complexes of the intra- and intermolecular hydrogen bonds was also established. Data are also presented on the solubility of Th mercaptobenzothiazolate in acetic acid. Its solubility reached a maximum of 33.8% in 0.34M acetic acid. (BBB)

11058 INFRARED SPECTRA OF THORIUM COMPLEXES. II. THORIUM MANDELATE, α-HYDROXYISOBUTYRATE, AND MALATE. I. Galateanu (Institutul de Fizica Atomica, Academiei R.P.R., Bucharest). Acad. Rep. Populare Romine Studii Cercetari Chim., 11: 343-52 (1963). (In Romanian)

Preparation of Th complexes with mandelic, α-hydroxyisobutyric, and malic acids in the solid state is reported. The mandelate was obtained as a precipitate by combining stoichiometric amounts of a 2M solution of mandelic acid (pH 1) with a 0.5M solution of Th nitrate. Analysis of the product confirmed the composition: $Th(C_6H_5CHOHCOO)_4 \cdot H_2O$. Thorium α-hydroxyisobutyrate was obtained by adding a solution of repeatedly recrystallized α-hydroxybutyric acid (2M) to the Th nitrate solution at evaporation of the solution (pH ~1) at 40°C. Thorium malate was prepared by adding a 2.5M solution of malic acid to an acidified (to pH ~ 0.5) 0.5M solution of Th nitrate. The product was purified by precipitation with alcohol. The infrared spectra of these complexes were studied in the spectral ranges of the LiF, NaCl, and KBr prisms. The spectral data showed that the mandelic and malic acid complexes form crystals and are dimers due to the intermolecular hydrogen bonds. Also, the carboxyl groups which take part in this reaction form chemical bonds with Th and the carbonyl of the carboxyl groups forms intra- or intermolecular hydrogen bonds. The spectral data show that the hydroxy groups of these acids probably form coordinative bonds with the Th only in the case of the α-hydroxyisobutyrate, while in Th mandelate and malate they form intra- or intermolecular hydrogen bonds owing to their spatial geometric position, which probably is not coplanar with the carboxyl groups. Thorium malate in solid state can be found in the form of dimers or polymers. In solutions at concentrations higher than 0.01M thorium malate is present also in the form of dimers. Below this concentration, it can be found as partially dissociated monomers. X-ray powder diagrams revealed that Th α-hydroxyisobutyrate and malate are amorphous complexes, while the Th mandelate has a crystalline structure. (BBB)

11059 SPECTROPHOTOMETRIC STUDY OF THE SYSTEM $UO_2^{2+}-CHCl_2COO^-$. P. Spacu, and Florica Popea (Inst. of Inorganic Chemistry, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Chim., 11: 353-62(1963). (In Rumanian)

A spectrophotometric study of the system $UO_2^{2+}-CHCl_2COO^-$ was made. The principle of continuous variations and the method of the molar ratio were applied; no conclusive results were obtained. The method of straight lines recently proposed by E. Asmus, evidenced however the formation of a complex $[UO_2(CHCl_2COO)_3]^-$ with a dissociation constant of 1.98. 10^{-4} mol^3/l^3. (auth)

11060 ENERGY TRANSFER IN SILICATE GLASS COACTIVATED WITH CERIUM AND YTTERBIUM. H. W. Gandy, R. J. Ginther, and J. Weller (Naval Research Lab., Washington, D. C.). Appl. Phys. Letters, 5: 220-2(Dec. 1, 1964).

The transfer of energy from Ce^{3+} to Yb^{3+} in a lithium–magnesium–alumino silicate glass is studied by a comparison of the excitation spectra for 1.015-μ radiation. The dominant mechanism of energy transfer is concluded to be radiationless because a considerable shortening of the Ce^{3+} emission decay time and a strong quenching of the Ce^{3+} emission are observed in the coactivated glass. (H.D.R.)

11061 A MAGNETIC FIXED POINT FOR THERMOMETRY BELOW 1°K. J. C. Eisenstein, R. P. Hudson, and B. W. Mangum (National Bureau of Standards, Washington, D. C.). Appl. Phys. Letters, 5: 231(Dec. 1, 1964).

A sharp peak was found in the zero-field differential susceptibility of $CeCl_3$ at 0.345°K. The possibility of using this peak as a thermometric fixed point is discussed. (H.D.R.)

11062 BUBBLE CHAMBER OBSERVATIONS OF PRE-BREAKDOWN PHENOMENA IN LIQUIDS. Y. Murooka, S. Nagao, and Y. Toriyama (Defense Academy, Obaradai, Yokosuka, Japan). Brit. J. Appl. Phys., 15: 1585-90(Dec. 1964).

Results of the phenomena, presumably derived from a cathode emission, which was photographed using a high-speed camera during research into the pre-breakdown phenomena in liquids in a bubble chamber are reported. It was found that the time required for the bubbles to reach an observable size (greater than 0.01 cm diameter) after the application of the field to the super-heated liquid, was approximately 0.5-0.8 msec. The pressure change of liquid in the bubble chamber was measured directly with a new type ceramic transducer, $Pb(Zr,Ti)O_3$. (auth)

11063 ION EXCHANGE MEMBRANES AND THEIR APPLICATIONS. Rene Buvet. Bull. Inform. Sci. Tech. (Paris), No. 85, 115-26(July-Aug. 1964). (In French)

After a brief description of the constitution of ion exchange membranes, the electrochemical properties of these membranes (internal composition-external composition equilibrium, conductivity, potentials, and transport properties under electrical and chemical stress) are analyzed. The application of ion exchange membranes to measurement of the differences of ionic chemical potentials, transformation of solutions, and production of electricity is reviewed. (J.S.R.)

11064 APPLICATIONS OF ELECTRODIALYSIS IN THE NUCLEAR INDUSTRY. A. Lecocq. Bull. Inform. Sci. Tech. (Paris), No. 85, 127-33(July-Aug. 1964). (In French)

The possible applications of electrodialysis in the nuclear industry are illustrated by the electrodialysis preparation of beryllium nitrate from the sulfate and the precipitation of hydroxides by migration of the anion of the initial salt. Particular problems of electrodialysis for its use in chemical conversions are discussed. (J.S.R.)

11065 LUMINESCENCE OF URANYL IONS DISSOLVED IN WATER AND GLYCEROL WATER MIXTURES AT LOW TEMPERATURES. Sohachiro Hayakawa and Masao Hirato (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Tech., Ser. B, No. 54, 19-30(Sept. 1963).

Fluorescence spectra of uranyl ions embedded in some host substances consist of narrow bands characteristic of the uranyl ion and its vibration modes, which are affected by the surroundings. The spectra in water and water-glycerol mixtures were observed in the temperature range from −190 to 0°C. Their fine structures depended on the temperature, the concentration of uranyl ion, and the consititution of the solvent. The solid state of the host substance should be considered to affect the spectra. The dielectric property was also measured in the same temperature range. The frequency of applied field was changeable between 120 cps and 10 kcps. The relation between the luminescent and dielectric properties is considered. (auth)

11066 SUBSTITUTED METHANES. PART XXXVI. CALCULATED WAVE NUMBERS, ASSIGNMENTS, AND THERMODYNAMIC PROPERTIES FOR CH_2DI AND CD_2HI, AND CALCULATED ROTATIONAL DISTORTION CONSTANTS AND MEAN AMPLITUDES FOR CH_3I AND CD_3I. Earle F. Ditzel, Arnold G. Meister, Edward A. Piotrowski, Forrest F. Cleveland, Y. Anantarama Sarma, and S. Sundaram (Illinois Inst. of Tech., Chicago). Can. J. Chem., 42: 2841-6(Dec. 1964).

A set of potential energy constants was obtained for CH_3I and CD_3I from their vibrational spectral data. From these constants, the rotational distortion constants and the mean amplitudes were calculated for these two molecules. The rotational distortion constants D_J, D_{JK}, and D_K were, respectively, CH_3I, 6.34, 59.36, and 3542.30; CD_3I, 3.90, 33.08, and 866.43 kc/s. The principal mean amplitudes of vibration in pm (pm = picometer = 10^{-12} meter = 10^{-2} Å) at 298.16 °K are CH_3I, 5.25 (C—D), 7.71 (C—H), 12.37 (H · · · H), and 12.00 (H · · · D); CD_3I, 5.14 (C—D), 6.63 (C—D), 10.85 (D · · · D), and 10.65 (D · · · D). The potential energy constants were used to obtain the wave numbers of CH_2DI and CD_2HI. A complete assignment of the observed wave numbers for the molecules CH_2DI and CD_2HI was made. The fundamental wave numbers for the gaseous state of CH_2DI are a′, 2980, 2235, 1418, 1170, 723, and 519; a″, 3091, 1266, and 871 cycles/cm. For CD_2HI, the corresponding values are a′, 3017, 2174, 1185, 1009, 757, and 508; a″, 2273, and 676. Using these wave numbers, the thermodynamic functions were calculated for the two molecules for 12 temperatures from 100 to 1000 °K for 1 atm pressure. The values of $(H^0 - E_0^0)/T$, $-(F^0 - E_0^0)/T$, S^0, and C_p^0 at 298.16 °K are, respectively, CH_2DI, 8.82, 54.66, 63.48, and 10.98; CD_2HI, 9.00, 55.20, 64.19, and 11.53 cal deg^{-1} mole^{-1}. (auth)

11067 INVESTIGATION OF HYDROGEN BOND BREAKING IN THE HOFMANN DEGRADATION OF QUATERNARY AMMONIUM HYDROXIDES BY THE HYDROGEN ISOTOPE EFFECT. Helmut Simon and Gerhard Muellhofer (Technische Hochschule, Munich). Chem. Ber., 97: 2202-8 (1964). (In German)

The magnitudes of the hydrogen isotope effects reported to date in the literature for the Hofmann degradation of quaternary ammonium hydroxides of the type $(CH_3)_3N^+-CH_2CH_2R$ show no clear dependence on R. The authors found an intramolecular ^3H isotope effect for R = H, CH_3, C_6H_5, and $C_6H_4NO_2$(p) at 60°C equal to 3.0, 2.9, ca. 4.2 and 8. Thus the hydrogen isotope effect is greater the easier the elimination proceeds. Small H isotope effects contrast with large effects on the C−N bond rupture. Inferences are drawn about the extent of C−H bond breaking in the transition state. Preparation of reagents with labels is for the most part described in other papers (Chem. Ber., 96: 3167 (1963), for example). The preparation of trimethyl-β-phenylethyl-(β-^{3}H)-ammonium hydroxide is given; 12.2 g phenylacetic acid was heated in 10 ml 30% NaOH containing 8 mC ^{3}H-water 18 hr at 100°C in a heavy walled glass vessel. Permanganate oxidation of a portion of this acid in 1.5N NaOH gave benzoic acid completely free of ^{3}H. The specifically β-labeled phenylacetic acid was then converted into the ammonium hydroxide by a known route (Saunders and Edison, J. Am. Chem. Soc., 82: 138(1960)); the tosylate of the product had a specific activity of 1.15×10^3 cpm μmol. (BBB)

11068 NORMAL AND INVERSE SECONDARY α-DEUTERIUM ISOTOPE EFFECTS WITH TRIMETHYLSULPHONIUM IONS. Ching-yong Wu and R. E. Robertson (National Research Council, Ottawa). Chem. Ind. (London), No. 43, 1803-4(Oct. 24, 1964).

It is shown that it is possible to have either normal or inverse α-deuterium isotope effects in the same solvent and in the same system for nucleophilic displacement from trimethylsulfonium ion. Bimolecular rate data for labeled and unlabeled trimethylsulfonium ions with a nucleophile in ethanol are given. Rates were determined by a conductimetric method and deuteration by mass spectrometry and nuclear magnetic resonance; it was shown to be better than 98% d_9. While the effect in two cases indicate a small dependence on temperature, no conclusion could be drawn from these results. However, with the stronger nucleophile there was a tendency toward an inverse effect, which is just the opposite of the trend found for displacement involving the uncharged methyl compounds cited above. (BBB)

11069 CONSTITUTION IN SOLUTION OF BASIC NITRATES OF SCANDIUM. Francine Fromage and Jacques Faucherre (Laboratoire de Chimie Generale, Faculté des Sciences, Dijon, France). Compt. Rend., 259: 3274-80 (Nov. 9, 1964). (In French)

The addition of an equivalent of strong base to a solution of scandium nitrate led to a soluble basic solution in which the cation was bicondensed and corresponded to the formula $[Sc_2(OH)_2]^{4+}$. Analogies with aluminum are drawn. (tr-auth)

11070 RELATIVE ISOTOPIC DISPLACEMENTS IN THE SPECTRUM OF URANIUM. Jean-Marie Gagné, Simon Gerstenkorn, and Jean-Marie Helbert (C.N.R.S., Bellevue, France and Commissariat a l'Energie Atomique, [France]). Compt. Rend., 259: 3479-82(Nov. 16, 1964). (In French)

By use of a Fabry-Perot photoelectric spectrometer and a method developed for precise calibration of the spectra recorded, the relative isotopic displacement (^{238}U−^{233}U)/(^{238}U−^{235}U) of 20 arc rays, pertaining to three different types of transition, $f^3ds^2-f^3dsp$, $f^3d^2s-f^3dsp$, and $f^3ds^2-f^3s^2p$, were measured. The relative isotopic displacement of all these rays was the same, within experimental error (about 1%), as that of the spark rays λ = 4244 Å ($f^3s^2-f^3dp$). The particularly favorable ray λ = 5027 Å (absence of hyperfine structure) allowed the value 1.555 ± 0.001 to be obtained for the relative isotopic displacement (^{238}U−^{233}U)/(^{238}U−^{235}U). (tr-auth)

11071 DISSOLUTION POTENTIALS AND DISINTEGRATION OF BERYLLIUM DISSOLVING IN SOME MINERAL ACIDS. M. E. Straumanis and D. S. Gnanamuthu (Univ. of Missouri, Rolla). Corrosion Sci., 4: 377-86(Dec. 1964).

Dissolution potential (ϵ')−time, ϵ'−acid-concentration, and ϵ'−current-density curves were obtained for Be dissolving in dilute HF, HCl, $HClO_4$, and H_2SO_4 at about 30°C. The potential increased with time in HF and H_2SO_4; in HCl and $HClO_4$ the potentials changed only slightly with time. The potential increased with increasing concentration of the acids only in HF; there was a pronounced decrease in HCl, $HClO_4$, and H_2SO_4. The potential increased linearly in all cases with current density, although in HF the measurements were very erratic. The most active values were obtained in HF (0.05N) with the sample containing the smaller amount of oxygen: about −1.15 v (hydrogen scale); the least active−in H_2SO_4 (0.2N): about −0.23 v. The small change in ϵ' with time and the downward trend of the ϵ'−acid-concentration curves were regarded as a symptom of disintegration of the dissolving anode. The ϵ'−current-density curves did not suggest a possible disintegration of Be. (auth)

11072 THE SOLUBILITY OF WATER AND URANYL NITRATE IN TRIBUTYLPHOSPHATE (TBP) FROM 0 to 100°C. A. V. Nikolaev, Yu. A. Dyadin, and I. I. Yakovlev (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 158: 1130-2(Oct. 11, 1964). (In Russian)

Equilibrium in the UO_2– TBP– H_2O system was attained in a thermostat. The experiments were carried out in such a manner that two liquid phases (aqueous and organic) and one solid phase were in equilibrium. The weight per cent of $UO_2(NO_3)_2$ in the TBP was 42.31% at 0, 44.26% at 25, 46.30% at 50, 48.38% at 65, 50.14% at 78, 51.70% at 92, and 53.11 wt. % at 100°C. The water content in the TBP was 0.15% at 0, 0.25% at 25, 0.54% at 50, 0.76 wt. % at 65, 1.14 wt. % at 79, 1.53 wt. % at 92, and 1.59 wt. % at 100°C. The solubility of water in TBP acually decreases with increasing temperature, and the above increase in the water content of the organic phase with increasing temperature is due to the fact that uranyl nitrate is extracted by TBP as the trihydrate. The $UO_2(NO_3)_2$– TBP– H_2O system is presented schematically on a triangular plot. The existence regions of $UO_2(NO_3) \cdot 6H_2O$ of $UO_2(NO_3)_2 \cdot 3H_2O$ are shown. (TTT)

11073 A RADIOMETRIC STUDY OF THE SORPTION OF OPPOSITE IONS ON COAGULATING ARSENIC AND ANTIMONY SULFIDE SOLS WITH ELECTROLYTE MIXTURES. A. A. Baran, Yu. M. Glazman, and D. N. Strazhesko (Pisarzhevskii Inst. of Physical Chemistry, Academy of Sciences, Ukrainian SSR and Kiev Technological Inst. of Light Industry). Dokl. Akad. Nauk SSSR, 158: 1146-8 (Oct. 11, 1964). (In Russian)

Lyophobic, negatively charged sols of As_2S_3 were coagulated by mixtures of $CaCl_2$ with RbCl and $SrCl_2$ and of $Ca(NO_3)_2$ and $Y(NO_3)_3$. The radioactive isotopes ^{86}Rb, ^{45}Ca, ^{89}Sr, and ^{91}Y were used as tracers. Coagulation was determined visually one hour after addition of the electrolyte mixture. Two series of experiments were set up at the same time for each electrolyte pair. One electrolyte was tagged in one series of experiments, and the other electrolyte was tagged in the other series of experiments. The total sorption of electrolyte was determined by adding separately the amounts of each electrolyte that were absorbed by the sol. The total sorption of both coagulating ions was constant over the entire coagulating region that was investigated. The ion sorption is ~ 109 μg-equiv per 1 gram of dispersed phase for the $CaCl_2$ and RbCl mixtures, ~ 73 μg-equiv per 1 gram of dispersed phase (Sb_2S_3) for the $CaCl_2$ and $SrCl_2$ mixtures, and ~ 109 μg-equiv per 1 gram of dispersed phase (As_2S_3) for the $Ca(NO_3)_2$ and $Y(NO_3)_3$ mixtures. (TTT)

11074 A THEORETICAL CALCULATION OF THE EMF OF THE GALVANIC ELEMENTS IN THE MOLTEN SALT SYSTEM $Be_{sol.}$ [$BeCl_n$ + MOLTEN KCl] $Cl_{2(gas)}$, C (GRAPHITE). M. V. Smirnov and A. P. Khaimenov (Inst. of Electrochemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 1172-5(Oct. 11, 1964). (In Russian)

The emf of the above galvanic elements can be calculated from the free energy changes of the following two reactions: $Be_{sol} + \frac{1}{2} Cl_2$ (gas) = Be^+ (melt) + Cl^- (melt) and $Be_{sol} + Cl_2$ (gas) = Be (melt) + 2 Cl^- (melt). The products of the above reactions are not formed in a pure form, but in the form of ions in a dilute KCl melt. The enthalpies and entropies of all steps in the process are known except for the conversion of gaseous beryllium and chlorine ions to ions in a dilute KCl melt. On carrying out the calculations, it is found that the entropy for the first reaction (BeCl) is $\Delta S^0 = -15.46 + 4.6 \lg [Be^+]$ cal/mole deg, and for the second reaction ($BeCl_2$) it is $\Delta S^0_{calc} = -44.89 + 4.6 \lg [Be^{2+}]$ cal/mole deg. The energy change for reaction 1 is $\Delta F_1 = -60{,}000 + 15.5\ T$ cal/mole, and the apparent standard electrode potential is $E^0(Be/Be^+) = \Delta F_1/23{,}062 = -2.60 + 6.8 \times 10^{-4} T$. For the reaction $Be_{sol} + Cl_2$ (gas) = $BeCl_2$ (melt), the free energy change is $\Delta F_2 = -156{,}000 + 44.9\ T$ cal/mole, and the standard electrode potential is $\Delta F_2/46{,}124 = -3.38 + 9.73 \times 10^{-4}\ T$. The theoretical values agree with the experimental values within 5% for Be^+, and within 15% for Be^{2+}. (TTT).

11075 METAL METHYLATES AND THEIR FORMATION EQUILIBRIUM. [PART] I. Rudolf Gut (Technische Hochschule, Zurich). Helv. Chim. Acta, 47: 2262-78 (Oct. 12, 1964). (In German)

A pH-scale was defined for absolute methanol as solvent and the ionic product of methanol was evaluated (20°, μ = 1.0, $N(CH_3)_4Cl$ or LiCl). The formation of methoxide complexes was studied by titration of methanolic solutions of BCl_3, $AlCl_3$, $GaCl_3$, $InCl_3$, PCl_3, $TiCl_4$, $ZrCl_4$, $ThCl_4$, $GeCl_4$, $ZnCl_2$, $TaCl_5$, $NbCl_5$, $NbOCl_3$, and $WOCl_4$ with lithium methylate. (auth)

11076 THERMAL DECOMPOSITION OF HYDRATED UO_3. H. Landspersky, L. Sedlakova, and D. Jakes (Nuclear Research Inst., Rez, Czechoslovakia). J. Appl. Chem. (London), 14: 559-63(Dec. 1964).

Calcination of ammonium polyuranate at temperatures between 350 and 600°C, with a rate of temperature increase of 1°C/min., yielded amorphous UO_3 having a surface area of about 30 m^2/g. More rapid increases in temperature gave mixtures of amorphous UO_3 + β-UO_3 with no reproducible surface area. To obtain pure amorphous UO_3, the mixtures were hydrated in water or in steam and then dehydrated. During hydration, the surface area decreased and the decrease continued during subsequent calcination, to give a final surface area between 3 and 5 m^2/g. (auth)

11077 THERMOELECTRIC AND ELECTRICAL MEASUREMENTS IN THE La–Te SYSTEM. T. H. Ramsey, H. Steinfink, and E. J. Weiss (Univ. of Texas, Austin). J. Appl. Phys., 36: 548-53(Feb. 1965).

An evaluation of the electric conductivity and Seebeck coefficient of the compounds in the La–Te system has indicated values of ρ from 0.1 Ω-cm to 20 × 10^3 Ω-cm. The bonding, based on earlier crystal-chemical studies and supported by this evaluation, indicates a variation from almost pure metallic in LaTe to metallic with a substantial ionic component in La_2Te_3. An evaluation of the Seebeck coefficient has further differentiated between the purely metallic and semiconducting nature of the various compounds. The evaluation was conducted on polycrystalline pressed-powders or sintered materials, and the energy-gap measurements are believed to be a measure of surface phenomena activation processes rather than an indication of true intrinsic character. (auth)

11078 LOW-TEMPERATURE LATTICE DISTORTIONS IN MnO AND EuTe. D. S. Rodbell, L. M. Osika, and P. E. Lawrence (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 36: 666-7(Feb. 1965).

An x-ray diffraction cryostat operating in the liquid-helium range of temperatures was used to make diffraction measurements on MnO to 4.2°K and on EuTe to 2.0°K. The lattice distortions connected with magnetic ordering in the two antiferromagnetic compounds were determined, and the role that these distortions may play in modifying the magnetic behavior of the compounds is discussed. (C.E.S.)

11079 EPITAXY IN THIN FILMS OF EuS. C. W. Chen and S. Zeitman (Westinghouse Electric Corp., Pittsburgh). J. Appl. Phys., 36: 669-70(Feb. 1965).

Single-crystalline films of EuS were grown epitaxially upon the (100) cleavage surface of single-crystal substrates of NaCl, NaBr, and MgO and upon the (111) cleavage surface of CaF_2. The use of Cu, Ge, Si, mica, and sapphire crystals, however, led to the formation of polycrystalline films only. The crystal structure of the substrate and the substrate temperature were found to be critical criteria for the epitaxial growth. (C.E.S.)

11080 ENTROPY, INTERNAL ENERGY, AND HEAT CAPACITY OF $MnCl_2$ BETWEEN 0° AND 4.2°K IN MAGNETIC FIELDS TO 100 kg. W. F. Giauque, E. W. Hornung, R. A. Fisher, and G. E. Brodale (Univ. of California, Berkeley). J. Chem. Phys., 42: 835-51(Feb. 1, 1965).

The thermodynamically reversible isothermal change of entropy of $MnCl_2$ with a magnetic field directed along the b magnetic axis was measured calorimetrically. At 1.498°K $(\partial S/\partial H)_T$ was positive below 7.5 kG, then negative to magnetic saturation. At 1.333°K, $(\partial S/\partial H)_T$ was negative below

4.5 kG, then positive to 9.25 kG, after which it was negative to saturation. The isothermal entropy change with field was also measured by a two-step process, in which the internal-energy change was obtained by combining calorimetric measurements with irreversible magnetic work; then the internal-energy change was combined with reversible measurements of magnetic work. Measurements of heat capacity in constant fields were repeated to improve accuracy and to apply a severe test of magnetothermodynamic reversibility by series of measurements made after varied approaches to the starting conditions. The entropy, internal energy, and heat content are given over the range from 0 to 4.2°K and 0 to 100 kG, and there was evidently no transition points in the entire area investigated, although gradual changes in magnetic structural types undoubtedly occur. Some values of the heat capacity at constant magnetic moment were calculated. (auth)

11081 THERMAL DIFFUSION COLUMN TRANSPORT COEFFICIENTS FOR MASS 28 AND MASS 29 CARBON MONOXIDE. W. M. Rutherford (Monsanto Research Corp., Miamisburg, Ohio). J. Chem. Phys., 42: 869-72(Feb. 1, 1965). (MLM-1225J)

Thermal diffusion column transport coefficients were measured for mass 28–mass 29 carbon monoxide in a 7.32-m-long, hot-wire column. The three coefficients that characterize column performance were independently evaluated at wire temperatures of 350 and 500°C from the results of both static and flow separation experiments at various pressures. If the value of the thermal diffusion factor at 288°K for carbon monoxide is assumed to be 0.0054, good agreement was obtained between the experimental coefficients and those predicted from existing theory with shape factor integrals based on the Lennard-Jones 12–6 potential. (auth)

11082 SPECTRA AND ENERGY LEVELS OF Er^{3+} IN YCl_3. J. W. Rakestraw and G. H. Dieke (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 42: 873-8(Feb. 1, 1965).

Yttrium chloride is monoclinic with C_2 point symmetry at the site of a Y^{3+} ion. The point symmetry is approximately octahedral. The absorption and fluorescence spectra of Er^{3+} in YCl_3 were used to find the energy levels of Er^{3+}. The Zeeman effect and the excitation of fluorescence were studied. Assuming a cubic field, the Stark splittings of the Z and Y groups were used to obtain the crystalline field parameters: $A_4\langle r^4\rangle = 175.\ cm^{-1}$ and $A_6\langle r^6\rangle = 10.4\ cm^{-1}$. The cubic field gave approximate agreement with the experimental data and explained the clustering of Stark components, which was characteristic of rare earth ions in YCl_3. The total Stark splitting of the free ion levels of a rare earth ion was larger in YCl_3 than in $LaCl_3$. The centers of gravity of the excited levels of Er^{3+} were higher in $LaCl_3$ than in YCl_3, and this shift increased with increasing wavenumber. (auth)

11083 INTERMOLECULAR ENERGY TRANSFER FROM EXCITED ORGANIC COMPOUNDS TO RARE-EARTH IONS IN DILUTE SOLUTIONS. Adam Heller and Edel Wasserman (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 42: 949-55(Feb. 1, 1965).

Population of luminescent levels of rare earth ions in solution was accomplished through energy transfer from excited, nonchelated organic molecules. Twenty-one aromatic aldehydes and ketones were found to be capable of transferring energy to Tb^{3+} or to Eu^{3+}. It is suggested that a diffusion-controlled process is necessary for transfer and the lowest triplet state of the organic excites the ion. Possible applications as laser materials are briefly considered. (auth)

11084 ANALYSIS OF THE IONIZATION OF CESIUM IN TUNGSTEN CAPILLARIES. A. Theodore Forrester (Electro-Optical Systems, Inc., Pasadena, Calif.). J. Chem. Phys., 42: 972-80(Feb. 1, 1965).

The transport of cesium through a tungsten capillary occurs through two phases, an adsorbed layer and a vapor. These two phases were connected by an experimentally observed relationship, rather than by a linearized approximation to it. The choice of allowed solutions was made by a precise boundary matching to solutions computed for the surface onto which the capillary opens. This analysis led to the possible existence of three different states of the system over a range of capillary sizes, temperatures, and flow-rate conditions. These three states were correlated with the front-surface emitting, pore emitting, and nonemitting states, which were observed to coexist for a porous ionizer. It is predicted that the coexistence of three different states disappears when the capillaries become extremely fine. (auth)

11085 ANISOTROPIC ZEEMAN EFFECT IN ERBIUM ETHYLSULFATE WHEN THE MAGNETIC FIELD IS PERPENDICULAR TO THE C UNIAXIS OF THE CRYSTAL. F. H. Spedding, W. J. Haas, W. L. Sutherland, and C. A. Eckroth (Ames Lab., Ames, Iowa). J. Chem. Phys., 42: 981-92(Feb. 1, 1965). (IS-996)

When single crystals of erbium ethylsulfate, possessing C_{3h}^5 symmetry, were placed in a magnetic field with the direction of the field, the direction of the incident light, and the crystalline c axis mutually perpendicular, the energy and intensity of certain of the absorption lines were found to exhibit a dependence on the angle ϕ_m between the direction of the magnetic field and a newly-defined crystalline x axis. Both the energy and intensity were periodic under 60° rotation about the c axis, but the maximum or minimum energy of every line occurred at $\phi_m = 0° + n60°$, while the maximum or minimum intensities of all the lines did not occur at a common angle. The energies of the levels, and their rotation coefficients and Zeeman splittings were determined for the ground term and for the line group at 27.500 cm^{-1}. The spectral data were used in measurement of the angle $\bar{\phi}$ between the usual crystallographic a axis and the x axis. This angle is a parameter which is a consequence of the C_{3h} point symmetry at the rare earth ion site and which is characteristic of the crystalline environment. The experimental findings were in qualitative agreement with the theoretical work of Murao, Spedding, and Good, and with the results of extended calculations. (auth)

11086 NUCLEAR QUADRUPOLE COUPLING IN POLYATOMIC MOLECULES. C. W. Kern and M. Karplus (Columbia Univ., New York). J. Chem. Phys., 42: 1062-71 (Feb. 1, 1965).

The Gaussian-transform method was applied to the evaluation of the deuteron and nitrogen-14 quadrupole coupling constant (eqQ/h) with the various minimal and extended basis-set SCF–LCAO–MO functions that are available for the linear polyatomic molecules DCN, C_2D_2, DF_2^-, and N_3^-. Comparisons were made between calculations neglecting and including the three-center integral contributions. The coupling constant was found to be quite sensitive to the choice of basis orbitals, particularly those responsible for the form of the valence-shell charge density. This suggested that the quadrupole coupling constant in polyatomic molecules is a useful criterion for testing the wavefunction obtained in approximate calculations. Of particular interest was the variation in the $(eqQ/h)_D$ results for DF_2^-, which pointed out the need for an experimental coupling constant measurement for this hydrogen-bonded species. (auth)

11087 MÖSSBAUER STUDIES OF IRON ORGANOMETALLIC COMPLEXES. IV. SIGN OF THE ELECTRIC-FIELD GRADIENT IN FERROCENE. R. L. Collins (Univ. of Texas, Austin). J. Chem. Phys., 42: 1072-80(Feb. 1, 1965).

The quadrupole splitting of ^{57}Fe Mössbauer spectra gives the magnitude, but not the sign, of the electric-field gradient. The sign can be determined by magnetically perturbing the energy levels, such that one line splits into a triplet and the other line splits into a doublet. A first-order perturbation treatment for the axially symmetric electric-field gradient case is given for powdered samples. The method was applied to ferrocene. A crystal-field treatment predicted a positive efg, and molecular orbital treatments predicted negative efg's. At 40 kG applied, the two lines split clearly into a doublet and a triplet. The result agreed with the molecular orbital treatment. This also explained the essential vanishing of the efg in ferrocinium compounds. (auth)

11088 LASER PHENOMENA IN EUROPIUM CHELATES. III. SPECTROSCOPIC EFFECTS OF CHEMICAL COMPOSITION AND MOLECULAR STRUCTURE. C.

Brecher, H. Samelson, and A. Lempicki (General Telephone & Electronics Labs., Inc., Bayside, N. Y.). J. Chem. Phys., 42: 1081-96(Feb. 1, 1965).

The emission spectra of the tris and tetrakis forms of four β-diketone chelates of europium were studied in the solid powder, and in alcohol solution with and without added dimethylformamide. Partial dissociation of the tetrakis form was observed in solution. Effective site symmetries, subject to steric distortion, were derived for the tetrakis-chelated europium ion in the various hosts: D_{2d} in pure alcohol, C_{4v} in alcohol plus dimethylformamide, and C_{4v} in the crystal. For the tris chelates, in both their hydrated and anhydrous forms, a number of different low-symmetry species were found to exist simultaneously in each host medium. The implications of these findings to the laser capabilities of the chelates are discussed. (auth)

11089 INFRARED SPECTRA AND VIBRATIONAL ASSIGNMENTS OF HBF_2 AND DBF_2. Lahmer Lynds (North American Aviation Science Center, Thousand Oaks, Calif.). J. Chem. Phys., 42: 1124-6(Feb. 1, 1965).

The vibrational assignments of both HBF_2 and DBF_2 were made utilizing the Green's function and matrix partitioning techniques. All the dynamics of the perturbed molecules were determined from the Green's function of the unperturbed molecules. Results showing the observed spectra (estimated band centers for A_1 modes) and vibrational assignments are collected in tabular form. (M.C.G.)

11090 ELECTRON-DIFFRACTION STUDY OF DIBORANE AND DEUTERODIBORANE. L. S. Bartell and B. L. Carrol (Ames Lab., Ames, Iowa). J. Chem. Phys., 42: 1135-9(Feb. 15, 1965). (IS-946)

The molecular structures of gaseous B_2H_6 and B_2D_6 were determined by the sector-microphotometer method of electron diffraction. Structural parameters and standard errors for B_2H_6 were $r_g(B-B) = 1.775_0 \pm 0.003_5$ Å; $r_g(B-H)_{term} = 1.196_0 + 0.008, -0.006$ Å; $r_g(B-H)_{bridge} = 1.339_3 + 0.002, -0.006$ Å; and $\angle BBH_t = 120.5 \pm 0.9°$. Corresponding parameters for B_2D_6 were $1.771_2 \pm 0.003_5$ Å; $1.198_0 + 0.006, -0.005$ Å; $1.333_5 + 0.002, -0.004$ Å; and 119.3 ± 0.9°. Root-mean-square amplitudes of vibration were also determined. Bridge hydrogen amplitudes exceeded terminal hydrogen amplitudes in conformity with an extension of Badger's rule. Hydrogen amplitudes exceeded deuterium amplitudes in accordance with the difference in reduced mass. Isotope effects on bond lengths were obscured by an unanticipated experimental flaw, which influenced results by 1 or 2 parts per thousand. (auth)

11091 ELECTRON-DIFFRACTION STUDY OF WATER AND HEAVY WATER. Shuzo Shibata and L. S. Bartell (Iowa State Univ., Ames). J. Chem. Phys., 42: 1147-51 (Feb. 15, 1965).

The structures of gaseous H_2O and D_2O were investigated using the sector-microphotometer method of electron diffraction. Structural parameters and estimated standard errors for H_2O included the mean bond length $r_g(OH) = 0.976 \pm 0.003$ Å, rms amplitude $l_g(OH) = 0.0666 \pm 0.003$ Å, and mean HOH angle $\alpha_g = 107.2° \pm 3°$. Corresponding values for D_2O were 0.970 ± 0.0025 Å, 0.564 ± 0.002 Å, and 104.2° ± 3°. Results agreed with spectroscopic values to within the larger limits of error of the diffraction results. Analyses were based on the radial distribution method and on an automatic "smooth-background" method. Observed atomic intensities deviated significantly at small scattering angles from intensities calculated using the conventional approximations. The resulting discrepancy led to a greater uncertainty in structural parameters than did the random experimental intensity errors. This almost universally neglected source of error is briefly discussed. (auth)

11092 SPIN-ROTATION INTERACTION AND MAGNETIC SHIELDING IN OF_2. W. H. Flygare (Univ. of Illinois, Urbana). J. Chem. Phys., 42: 1157-61(Feb. 15, 1965).

High-resolution microwave spectroscopy was used to study the spin-rotation interaction of the two ^{19}F nuclei in OF_2. Several transitions were resolved from J = 9 to J = 26 where half-widths at half-heights of 12 to 15 kc/sec were obtained. The chemical shift of the ^{19}F nucleus was also measured. The value of the magnetic shielding relative to F in $CFCl_3$ was −249 ± 1 ppm. The paramagnetic component of the shielding in OF_2 ($\sigma_{OF_2}^P$) was then related to the paramagnetic shielding in F_2 ($\sigma_{F_2}^P$) yielding $\sigma_{OF_2}^P - \sigma_{F_2}^P = 205 \times 10^{-6}$. The value for $\sigma_{OF_2}^P$ can be computed from the known spin-rotation constant in F_2 yielding $\sigma_{OF_2}^P = -569 \times 10^{-6}$. These data are then combined with the microwave data on the spin-rotation interaction of OF_2 to yield $M_{aa} = -42$ kc/sec, $M_{bb} = -22$ kc/sec, and $M_{cc} = -49$ kc/sec. (auth)

11093 DIFFUSION OF BORON IN GRAPHITE. Gerhart Hennig (Argonne National Lab., Ill.). J. Chem. Phys., 42: 1167-72(Feb. 15, 1965).

The mobility of substitutional boron in single crystals of graphite was measured by an etch-decoration method, which made it possible to locate individual boron atoms by electron microscopy. The mobility of boron was not very sensitive to the boron concentration for B/C values between 10^{-2} and 10^{-8}. The diffusion constants measured between 1700 and 2400°C were 6320 exp (−157,000/RT) for motion parallel to the layer planes and 7.1 exp (−153,000/RT) for motion perpendicular to the layers. (auth)

11094 NUCLEAR MAGNETIC DOUBLE RESONANCE. TRANSMISSION OF MODULATION INFORMATION THROUGH THE NUCLEAR SPIN-SPIN COUPLING. R. Freeman and W. A. Anderson (Varian Associates, Palo Alto, Calif.). J. Chem. Phys., 42: 1199-1229(Feb. 15, 1965).

Nuclear magnetic double-resonance experiments are described in which the perturbing radiofrequency field is amplitude or frequency modulated, causing the precessing moment vector of a group of nuclear spins (S) to mutate at a low audio frequency. Through the action of the nuclear spin–spin coupling this modulation information is transmitted to a second group of nuclear spins (I) in the form of a selective modulation of the local magnetic field, which may be used to excite a magnetic resonance "sideband" signal. A general theory is given, covering both the present modulation transfer experiments and the removal of residual splitting in spin decoupling experiments by modulation of the irradiating frequency. Numerical calculations to predict the frequencies and relative intensities of the observed signals were carried out on a high-speed computer and presented in graphical form. In all the experimental measurements the S spins were ^{13}C nuclei in their natural abundance, and the I spins were coupled protons, examined at 60 Mc/sec. Good agreement with the theoretical predictions was obtained in a detailed study of the AX spin system of chloroform. The application of modulation transfer experiments to the indirect measurement of ^{13}C chemical shifts was illustrated for chloroform, acetic acid, and diethyl ether. The technique was also used to discriminate between signals from molecules with different isotopic constitution; for example, in acetic acid all proton signals from molecules not containing ^{13}C may be suppressed, clearly revealing the small long-range spin coupling between carboxyl ^{13}C and the methyl protons. In more complex molecules the theoretical frequency and intensity diagrams can be built up by superposition of the diagrams for simpler systems. Often the relative signs of certain coupling constants may be inferred by inspection of the modulated double resonance spectrum, the relative signs of $J(^{13}CH)$, $J(^{13}CCH)$, and J(HH) in diethyl ether were determined in this way. (auth)

11095 INFRARED AND RAMAN SPECTRA OF KRYPTON DIFLUORIDE. Howard H. Classen, Gordon L. Goodman, John G. Malm, and Felix Schreiner (Argonne National Lab., Ill.). J. Chem. Phys., 42: 1229-32(Feb. 15, 1965).

The infrared and Raman spectra of KrF_2 vapor were obtained. They clearly indicated a linear and symmetric molecule with the symmetric stretching frequency at 449 cm^{-1}, the asymmetric stretching frequency at 588 cm^{-1}, and the bending frequency at 232.6 cm^{-1}. The force constants are $f_r = 2.46$, $f_{rr} = -0.20$, and $f_a = 0.21$ mdyn/Å. The negative bond–bond interaction constant can be explained

neither by valence bond models nor by a simple molecular orbital model. (auth)

11096 INFRARED INTENSITIES OF THE FUNDAMENTAL VIBRATIONS OF GeH_4 AND GeD_4. Ira W. Levin (National Inst. of Health, Bethesda, Md.). J. Chem. Phys., 42: 1244-51(Feb. 15, 1965).

The absolute infrared absorption intensities of the fundamental vibrations of GeH_4 and GeD_4 were measured using nitrogen pressures of 900 psi to broaden the individual rotational lines. Alternative sets of the derivatives of the dipole moment with respect to designated stretching and bending symmetry coordinates were obtained. A least-squares analysis of the isotopic data indicated that the positive ratio of the two dipole-moment derivatives is the preferred solution. (auth)

11097 NUCLEAR SPIN COUPLING BETWEEN GEMINAL HYDROGEN ATOMS. J. A. Pople and A. A. Bothner-By (Carnegie Inst. of Tech., Pittsburgh and Mellon Inst., Pittsburgh). J. Chem. Phys., 42: 1339-49(Feb. 15, 1965).

A molecular orbital theory of nuclear spin coupling between geminal hydrogen atoms was developed and found to give a satisfactory interpretation of substituent effects evident in experimental data. The theory suggests that the value of geminal coupling constants provides a means of distinguishing between inductive and hyperconjugative electron transfer. A number of geometrical rules are proposed, which should make these constants valuable in studies of molecular conformation. (auth)

11098 ISOTOPIC MIXING IN CO CHEMISORBED ON TUNGSTEN. A KINETIC STUDY. T. E. Madey, J. T. Yates, Jr., and R. C. Stern (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 1372-8(Feb. 15, 1965).

When $^{12}C^{18}O$ and $^{13}C^{16}O$ were adsorbed together on tungsten, rapid isotopic mixing to form $^{12}C^{16}O$ and $^{13}C^{18}O$ occurred at temperatures above 850°K. These temperatures corresponded to the desorption temperatures of the more strongly held adsorbed CO species (β states). No evidence was found for dissociation of CO into mobile adsorbed C and O atoms. A four-center bimolecular exchange intermediate on the surface was postulated. This was consistent with a model for molecular CO chemisorption on tungsten, which involves surface bonding through both the carbon and oxygen. The rate constant for the bimolecular surface-exchange reaction is $1.9 \times 10^{-10} \exp(-30{,}000/RT)$ cm^2/molecule · sec. (auth)

11099 X-RAY INVESTIGATION OF A HIGH-PRESSURE PHASE OF NH_4F AND ND_4F. B. Morosin and J. E. Schirber (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 42: 1389-90(Feb. 15, 1965).

X-ray powder diffraction patterns were obtained for high-pressure modifications of NH_4F and ND_4F under purely hydrostatic conditions. The structure of both salts could be indexed in a tetragonal unit cell, $a_0 = 10.2$ and $c_0 = 3.37$ Å. The transition was observed at 3.64 ± 0.02 kbar for both ND_4F and NH_4F. The zero-pressure lattice parameters were determined to be $a_0 = 4.4389 \pm 0.0004$, $c_0 = 7.1635 \pm 0.0004$, and $a_0 = 4.4378 \pm 0.0004$, $c_0 = 7.1635 \pm 0.0004$ Å for NH_4F and ND_4F, respectively. (auth)

11100 VIBRATIONAL ANALYSIS AND ISOTOPE EFFECTS IN HYDROGEN SELENIDE. R. A. Hill and T. H. Edwards (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 42: 1391-6(Feb. 15, 1965).

Values of the band origins for the near-infrared rotation-vibration bands $\nu_1 + \nu_2$, $\nu_2 + \nu_3$, $2\nu_1 + \nu_3$, $\nu_1 + 2\nu_3$, $3\nu_1$, and $3\nu_1 + \nu_3$ of $H_2{}^{80}Se$ were determined directly from their respective $^PP_j(J)$ and $^RR_j(J)$ lines. A vibrational analysis of the band origins of these six bands, of four previously analyzed combination bands, and of the three fundamentals led to values for the zero-order frequencies, anharmonic constants, and the interaction matrix element for a second-order resonance between levels of the type (ν_1, ν_2, ν_3) and $(\nu_1 - 2, \nu_2, \nu_3 + 2)$. Values for the isotopic band center separations $\Delta\nu_0 \equiv \nu_0(H_2{}^{80}Se) - \nu_0(H_2{}^{i}Se)$ and for $\Delta C_0 \equiv {}^{80}C_0 - {}^{i}C_0$, where i = 82, 78, 77, and 76, were obtained from the observed isotopic separations of the $^PP_j(J)$ and $^RR_j(J)$ lines for several bands. These empirical values of $\Delta\nu_0$ were compared with a set of theoretical values calculated using Krimm's approximate isotopic frequency rule and the vibrational constants for $H_2{}^{80}Se$. Values of $^{i}A_0$, $^{i}B_0$, and $^{i}C_0$ were calculated by combining the values of $^{80}A_0$, $^{80}B_0$, and $^{80}C_0$ with the empirical values of ΔC_0 and with values of $\Delta(A_0 - C_0)$ and $\Delta(A_0 - B_0)$ obtained from Oka and Morino's analysis of the microwave data of Jache, Moser, and Gordy. An equilibrium H—Se—H bond angle of 90°34′ and H—Se bond length of 1.460 Å were calculated using a set of α's, which were obtained from the rotational constants of $2\nu_1$, $\nu_1 + \nu_3$, $\nu_1 + \nu_2 + \nu_3$, and the ground state constants. (auth)

11101 IONIC REACTIONS OCCURRING IN SULFURIC ACID. IV. TRITIUM EXCHANGE BETWEEN TRITIATED SULFURIC ACID AND ISOPARAFFINS. J. E. Hofmann (Esso Research and Engineering Co., Linden, N. J.). J. Org. Chem., 29: 3039-42(Oct. 1964).

A study was directed toward elucidating the mechanism of formation of pentanes, hexanes, heptanes, nonanes, and higher saturated paraffins during the course of sulfuric acid catalyzed alkylation of isobutane with butylenes. Specific reactions of the various ionic species were studied to provide data concerning the reactivities of the various postulated ionic intermediates. Rates of tritium-protium exchange were measured between H_2SO_4—H and a series of isoparaffins. By use of these exchange rates as criteria for relative ease of carbonium ion formation, it was found that the ease of forming a carbonium ion decreases with increasing isoparaffin molecular wt. When skeletal isomerization is possible, such isomerization occurs to give products that approach thermodynamic equilibrium among hydrocarbons with the same extent of chain branching. For 11 hydrocarbons the specific activities relative to that of methylcyclopentane are shown, as well as by-products formed during the reaction. Product compositions were measured starting with 2- and 3-methylpentane, and 2,3- and 2,4-dimethylpentane; in each case, the other isomer was the only product observed. In all four cases, approach to equilibrium is about 75—90% complete. Relative rates are compared as a function of carbon number with the degree of substitution as a parameter. The only compound tested that did not contain a tertiary C—H bond, 2,2-dimethylbutane, underwent no exchange. Since exchange between carbonium ions and sulfuric acid is rapid compared to hydride transfer, the rate of tritium incorporation will be a measure of either the rate of ion formation or regeneration. The data show that methylcyclopentane incorporates tritium three to 40 times faster than any of the hydrocarbons tested and it has generally been accepted that this naphthene is an excellent hydride donor. Thus, for the paraffinic hydrocarbons, ion formation will be the rate-determining step. That the ease of ion formation drops off rapidly with increasing molecular wt is attributed to steric shielding of the tertiary C—H bond or decreased solubility as the bulkiness of the alkyl groups increases. (BBB)

11102 STABILITY OF PROCAINE IN DEUTERIUM OXIDE. F. P. Siegel, F. D. Hiter, S. V. Susina, and M. I. Blake (Univ. of Illinois, Chicago). J. Pharm. Sci., 53: 978-9 (1964).

The rates of hydrolysis of procaine in protium and deuterium oxides were compared over the pH range 8.0 to 11.0, and the effect of elevated temperature was also noted. Over this pH range the rate of deuteriolysis of procaine was less than the rate of hydrolysis. Over the pH range 8 to 11 and at 40°C the ratio of half lives in D_2O and H_2O is greatest at pH 8 (3.0) and decreases to a value of 1.2 at pH 11. Considerably higher ratios were obtained when the data at the equivalent pH and pD were compared. For example, when procaine in H_2O at pH 9.0 was compared with procaine in D_2O at pD 8.9, the ratio of half lives was 5.8. However, when aqueous procaine at pH 9.0 was compared with procaine in D_2O at apparent pH 9.0, the ratio was 2.0. This indicates that increased stability in D_2O is not simply a pH effect. At 100°C and pH 8, procaine is twice as stable in D_2O as in H_2O. The kinetic data give a typical first-order

plot. As shown earlier, the anesthetic activity of procaine, as observed on the cornea of the guinea pig, is greater in D_2O by a factor of 2. Since the anesthetic activity of procaine is due solely to free base which is predominant in the alkaline pH range, increased activity is, therefore, attributed to a greater stability (in vivo) of procaine base in D_2O. Further, at the same pH and apparent pH, a D_2O solution of procaine may contain more free base than in the corresponding aqueous solution. (BBB)

11103 THERMODYNAMIC CONSIDERATIONS IN MOLTEN METAL–METAL SALT SOLUTIONS. L. E. Topol (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 69: 11-17(Jan. 1965).

The standard free energies of solution of isolated metal atoms with the molten chloride of that metal were calculated from vapor pressure and solubility data for 34 systems. Based on the values of these standard free energies of dissolution, a useful correlation was obtained. This correlation allows systems to be classified in terms of the magnitude of the energies and to estimate solubilities in some systems where experimental data are not available. (auth)

11104 THE HYDROGEN–DEUTERIUM EXCHANGE REACTION. I. 6^3P_1 MERCURY PHOTOSENSITIZED. H. Niki, Yves Rousseau, and Gilbert J. Mains (Carnegie Inst. of Tech., Pittsburgh). J. Phys. Chem., 69: 45-52(Jan. 1965).

The kinetics of the $^3P_1$ Hg-photosensitized H_2-D_2 exchange is described by the differential rate law, $d(HD)/dt = A - k(HD)$. The photostationary constant, $Q_\infty = (HD)^2/(H_2) \cdot (D_2)$, at 25°C is a function of initial H_2-D_2 ratio, the total pressure in the range 0.2–30 cm, and surface-to-volume ratio, and is larger than the equilibrium constant, K. Initial rate studies of the forward reaction at 25°C as a function of H_2-D_2 pressure indicate the exchange reaction to occur via both a heterogeneous and a homogeneous mechanism. Initial rate data for HD formation are shown to be consistent with a heterogeneous combination of atomic hydrogens in competition with a reversible homogeneous chain mechanism. At 25°C and 1 cm of H_2-D_2 pressure, approximately 80% of the HD is formed on the walls; at 25°C and 30 cm of H_2-D_2 pressure, the wall reaction accounts for no more than 15% of the HD. Q_∞ is shown to approach K as both the temperature and pressure are raised. The mechanistic implications of these observations are discussed. (auth)

11105 THE EXCHANGE OF METHANOL BETWEEN SOLVATED CATIONS AND SOLVENT. PART II. Terrence E. Rogers, James H. Swinehart, and Henry Taube (Univ. of Chicago and Stanford Univ., Calif.). J. Phys. Chem., 69: 134-40(Jan. 1965).

The exchange of methanol between solvated Co^{2+} or Ni^{2+} and methanol as solvent was studied by the isotopic dilution method. The enthalpy of activation ΔH^*, for the exchange process is 11.5 ± 0.7 kcal/mole for Co^{2+} and 13.1 ± 0.7 kcal/mole for Ni^{2+}. Qualitative observations were made on methanol–water solvation equilibria for Co^{2+} solutions in CH_3OH containing some H_2O. The kinetic solvation number was found to be 6. Preliminary data for the $PrCl_3$–methanol system indicate that solvation of Pr^{2+} in CH_3OH can be studied by the isotopic dilution method. In this case it appears that H_2O in small amounts decreases the lability of the solvation methanol. Analysis of the isotopic dilution data for the perchlorate salts of Co^{2+}, Ni^{2+}, or Fe^{3+} showed that in certain cases the holdback of methanol for each mole of solute may exceed that ascribable to first coordination sphere interactions. (auth)

11106 THE KINETICS OF THE REACTION BETWEEN VANADIUM(II) AND URANIUM(VI). T. W. Newton and F. B. Baker (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 69: 176-81(Jan. 1965). (LA-DC-6497)

Uranium(VI) was found to catalyze the reaction between V(II) and V(IV) in aqueous perchlorate solutions. The rate of the catalyzed reaction is limited by that of the reaction between V(II) and U(VI), the kinetics of which were studied from 0.6 to 36.8°C, from 0.05 to 2.0 M $HClO_4$, and from 0.08 to 2.0 M ionic strength. The only important term in the rate law is $k_1[V(II)][U(VI)]$. Values of ΔS^* and ΔH^* for this term are −26.1 ± 0.4 eu and 7.1 ± 0.1 kcal/mole at μ = 2.0 M and −33.7 eu and 6.7 kcal/mole extrapolated to μ = 0. Both chloride and sulfate ions catalyze the reaction. (auth)

11107 STUDIES ON THE TRIPLET–TRIPLET ENERGY TRANSFER TO RARE EARTH CHELATES. M. L. Bhaumik (Electro-Optical Systems, Inc., Pasadena, Calif.) and M. A. El-Sayed. J. Phys. Chem., 69: 275-80(Jan. 1965).

Intermolecular triplet-triplet energy transfer between aromatic carbonyls and aromatic hydrocarbons as donors and rare earth chelates as acceptors is demonstrated. This is accomplished by observing the phosphoresence from the triplet level of gadolinium chelate, as well as the intramolecularly sensitized emission of the Eu^{3+} ion in europium hexafluoroacetylacetonate. The transfer is shown to be diffusion controlled. The possibility of the transfer taking place via actual chemical reaction is discussed, but evidence indicates it to be highly improbable for the chelate-benzophenone system. The transfer from the benzophenone triplet level to the chelate triplet level was not found to be more efficient than that between benzophenone and naphthalene. This indicates that the heavy ion has little effect on the transfer probability. At concentrations of ~ 10^{-3} mole/l the transfer between the ketone and the europium chelate triplet levels was found to be more efficient than the transfer between ketone and the bare Eu^{3+} ion. At higher concentrations, however, a rather efficient transfer of energy from the ketone to the ion was observed. Application of the last class of material for laser purposes is discussed. (auth)

11108 STUDIES OF GASEOUS ATOM-MOLECULE REACTIONS BY ELECTRON PARAMAGNETIC RESONANCE SPECTROSCOPY. C. C. McDonald and R. J. Goll (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Phys. Chem., 69: 293-7(Jan. 1965).

Gaseous atom-molecule reactions were investigated by a technique that combines magnetic-dipole and electric-dipole EPR spectroscopy. The technique was used to study some elementary reactions that produce OH, to detect EPR spectra of SH, SD, and SO, and to examine transient species in a number of other atom-molecule reactions. (auth)

11109 DIFFUSION STUDIES. I. DIFFUSION COEFFICIENTS IN LIQUIDS BY A RADIOMETRIC POROUS-FRIT METHOD. Arthur E. Marcinkowsky, Frederick Nelson, and Kurt A. Kraus (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 69: 303-9(Jan. 1965). (ORNL-P-376)

A porous-frit method for measuring self-diffusion coefficients and tracer diffusion coefficients of solutes in liquid systems was investigated. A thin slab of porous material (e.g., porcelain) is saturated with a solution containing a radioisotope of the element of interest. A solution of the same composition, but not containing tracer, is rapidly pumped past the frit. From the counting rate of the frit as a function of time, the diffusion coefficient ($\mathscr{D}$) is obtained after calibrating the frit with a solute of known $\mathscr{D}$. Through use of γ-energy discrimination techniques and appropriate recording equipment, the method may be applied to simultaneous measurement of diffusion coefficients of several radioisotopes. The method is rapid and yields values of $\mathscr{D}$ accurate to a few per cent. Typical examples of diffusion coefficient measurements in aqueous solutions are presented. (auth)

11110 EFFECT OF TEMPERATURE ON THE ADSORPTION OF COPPER(II), SILVER(I), OXALATE(II), AND FERROCYANIDE(IV) BY DIFFERENT SAMPLES OF PRECIPITATED HYDROUS THORIUM OXIDE. Rameshwar Prasad and Arun K. Dey (Univ. of Allahabad, India). Kolloid Z., 183: 71-4(May 1962).

The adsorption of these inorganic ions to various samples of $Th(OH)_4$ at 25, 40, and 55°C was studied. Four $Th(OH)_4$ samples A, B, C, and D, were precipitated by adding calculated amounts of a standard solution of NaOH to 500 ml. of 0.25M $ThCl_4$ solution. Results showed that A, precipitated with 10% deficient NaOH; B, precipitated with equivalent NaOH; C, precipitated with 5% excess NaOH; D, precipitated with 10% excess NaOH. The adsorptive capacities of the different samples for Cu(II) lie in an order expected except in the case of D where the adsorption is minimum. In the case of Ag(I) the adsorption is maximum

with the sample A. The adsorption with other samples B, C, and D, are similar to that in the case of Cu(II). In the case of the anions the adsorption is maximum with sample A and the adsorption with other samples lies more or less in decreasing order with increase in acidic nature of the hydroxide. A scheme is proposed whereby polymerization of the hydroxide results from loss of hydration. (BBB)

11111 ELECTROMETRIC STUDIES OF THE PRECIPITATION OF THORIUM HYDROXIDE. PART I. CHANGES IN pH OF THORIUM CHLORIDE SOLUTION BY THE PROGRESSIVE ADDITION OF SODIUM HYDROXIDE. Rameshwar Prasad and Arun K. Dey (Univ. of Allahabad, India). Kolloid. Z., 184: 54-6(July 1962).

It was observed in pH studies on the precipitation of thorium hydroxide by interaction between various concentrations of thorium chloride and sodium hydroxide, that complete precipitation occurs near pH 7. The results also showed that concentration has little effect on the pH of complete precipitation. The inflection points of all the curves occur before the addition of four equivalents of alkaki, confirming that complete precipitation occurs with an amount of alkali less than the theoretically equivalent amount. It was also noted that the inflection point with dilute solutions is at ~ four equivalents, in conformity with the analytical results which indicated that with progressive dilution of the solutions, precipitation occurs with amounts of alkali that are nearer the theoretical precipitation value. (BBB)

11112 DIFFUSION FROM A SATURATED SAMPLE (RARE GAS DIFFUSION IN SOLIDS 18). H. Gaus (Hahn-Meitner-Institut für Kernforschung, Berlin). Nukleonik, 6: 322-5(Oct. 1964). (In German)

A body is considered with a uniform distribution of dissolved gas at the time t = 0. For t > 0, diffusion of the gas and simultaneous evaporation of the body is assumed. For sufficiently small evaporation, the corresponding diffusion problem with time variable boundary condition can be solved by successive approximation. This was done in first order for a sphere. For larger evaporation, approximation formulas for the resulting gas release in small times (small diffusion depth) was obtained in an elementary way. The approximation equations were valid for more general body forms and in agreement with the result obtained. The calculation of the diffusion coefficient from the release curve is discussed. (auth)

11113 LINE SHIFT IN THE VISIBLE SPECTRUM OF Cd^{114} DUE TO (VARIATION OF) THE ARGON PRESSURE IN A LAMP WITH HEATED ELECTRODES. Yu. P. Efremov and S. N. Ivashevskii. Opt. Spectry. (USSR) (English Transl.), 17: 334(Oct. 1964). Translated from Optika i Spektroskopiya, 17: 620-2(Oct. 1964).

The interference orders were studied at the center of rings of equal slope for spectral lines emitted by two lamps with heated electrodes. The pressure of Ar in one of these (reference) was kept at 1.5 mm Hg and in the other (experimental) was varied from 0.5 to 40 mm Hg. Conditions of excitation, current density, and wall temperature were kept constant. Results are presented on the shift of four lines in the visible spectrum of ^{114}Cd as a function of Ar pressure in the lamps. (J.R.D.)

11114 REFRACTOMETRIC STUDY ON THE FORMATION IN AQUEOUS SOLUTION OF LANTHANUM AND CERIUM COMPLEX HALIDES. P. Spacu, Ileana Albescu, and Eugenia Dragomir (Inst. of Inorganic Chemistry, Bucharest). Rev. Chim., Acad. Rep. Populaire Roumaine, 8: 31-49(1963).

The formation in aqueous solution of alkaline halogenolanthanates and cerates of type: $[Me^{III}Cl_6]\,Me^{I}_3$; $[Me^{III}Cl_5]\,Me^{I}_2$; $[Me^{III}Cl_4]\,Me^{I}$ where Me^{III} = La, Ce, and Me^{I} = Na, K, Cs, was evidenced by the refractometric method, applying the principle of continuous variation. Working with 0.5 molar aqueous solutions in the same conditions, in the case of systems of the type: $Me^{III}Br_3$–MeBr where Me^{III} = La, Ce, and Me^{I} = Na, K, it was found that no compound of superior order is formed. As predicted theoretically the possibility of forming bromocompounds is reduced. (auth)

11115 A MAGNETO-OPTIC STUDY OF MOLTEN SALTS AT HIGH TEMPERATURES. Jerzy Zarzycki and Francis Naudin (Compagnie de Saint-Gobain, Paris). Rev. Hautes Temp. Refractaires, 1: 121-37(Apr.-June 1964). (In French)

Using specially designed apparatus for the study of liquids at high temperatures, Verdet's constant and the refraction index of a series of ionic salts in molten state were obtained. A parallel study of molar refraction and magnetic rotation revealed the existence of intense ionic interactions in liquid state. Through a suitable combination of the chromatic dispersion expressions of refraction and magnetic rotation the vibration frequencies of electrons were calculated: i.e., the position of the fundamental absorption band in the far ultraviolet of ionic salts in molten state was indirectly determined. The variations of the absorption frequency were observed during fusion in the case of the following crystalline halides: LiF, NaF, NaCl, KCl, KBr, KI and CsI. These experiments confirm the existence of a "lacunar" structure of molten salts alkali halides and complete the model deduced from a study of x-ray diffraction. (auth)

11116 THE V_2O_5–ThO_2 SYSTEM. Gilles Le Flem and Paul Hagenmuller (Faculté des Sciences, Bordeaux). Rev. Hautes Temp. Refractaires, 1: 149-52(Apr.-June 1964). (In French)

Three new phases were brought to light in the V_2O_5–ThO_2 system: metavanadate $Th(VO_3)_4$, pyrovanadate ThV_2O_7 and orthovanadate $Th_3(VO_4)_4$. Their fields of existence and the crystalline parameters of orthovanadate are reported. (auth)

11117 THE MOLECULAR STRUCTURES OF COMPOUNDS OF RARE-GAS ELEMENTS. Shoichiro Yamada (Osaka Univ.). Rev. Phys. Chem. Japan, 33: 39-40(1963).

Theoretical interpretation of the chemical bonding involved in xenon fluoride and related compounds is attempted. It is suggested that the structures of these compounds may be predicted qualitatively by simple theory. The stereochemistry of an atom in a molecule is determined by the size of its valency shell including the lone pairs, and the lone pairs are equally as important as the bonding pairs in this respect. In the terminology of co-ordination chemistry, this theory assumes, in the imaginary process of deriving the structures of the molecule, the co-ordination of ligands with the central ion of Kossel-type, the long pairs being regarded as equivalent to the other ligands. The theory has been improved by taking account of the differences in the electrostatic repulsions between lone pairs, between lone pairs and bonds, and between bonds themselves. On the basis of this theory, the structures of the compounds of rare-gas elements are predicted and their configuration shown. Thus the molecular structure of xenon trioxide, XeO_3, is pictured as derived through co-ordination of three O^{2-} ions and one lone pair of electrons to a Xe^{8+} core. The molecular structures of xenon difluoride, xenon tetrafluoride, and xenon trioxide, determined previously, were found to be in agreement with the structures predicted here. The structures of compounds of other rare-gas elements, such as KrF_4, if they can be prepared, are also predicted. It is pointed out that the predicted structure for xenon hexafluoride shows some distortion from a regular octahedron. It is concluded that this theory, which has proven to be qualitatively valid in predicting the structure of compounds of typical elements and many transition-metal elements, also applies to the compounds of rare gases. (BBB)

11118 PREPARATION OF URANIUM HYDRIDE IN A QUARTZ TUBE FOR SPECTRAL RESEARCH. I. I. Georgescu and V. M. Voljin. Rev. Roumaine Phys., 9: 55-62(1964). (In Russian)

A method for the preparation of UH_3 at low pressures (10 to 40 mm Hg), that is simpler than previous methods, is described. The preparation is done in a quartz tube and uses hydrogen from the electrolysis of water. The uranium–hydrogen reactions at low pressures is slower than that indicated by the literature at pressures from 1 to 120 atm. The substance prepared was used for the con-

struction of a hydrogen tube for spectral studies, in which hydrogen furnished by the thermal dissociation of uranium hydride is used. The optical spectrum was obtained by high frequency excitation at 20 to 30 MHz at 200 to 400 w. The molecular spectrum of the hydrogen, obtained both by transmission as well as by reflection on a thin film of silver oxide of 700 Å is very pure. The structural analysis by x rays established that the substance thus prepared is identical, from the crystallographic viewpoint, to that analyzed by Rundle, but obtained at pressures of approximately 126 atm. By comparing the intensity of the Debye rays of the metallic uranium and the hydride uranium, it was established that the yield is about 23%. This indicates that the measurements are made on the horizontal portion of the isotherm of dissociation and formation of UH_3. The dissociation-recombination hysteresis was observed, but it was noticed that the complete re-establishment of the equilibrium requires a considerably longer time than indicated in the literature. (tr-auth)

11119 ISOTOPIC SOLID SOLUTION FREQUENCIES AND ASSIGNMENTS IN THE 800 cm^{-1} REGION IN DIMETHYLSILANES. D. F. Ball and D. C. McKean (Univ. of Aberdeen, Old Aberdeen, Scotland). Spectrochim. Acta, 21: 204-6(Jan. 1965).

Infrared spectra of solid solutions of isotopic samples of dimethylsilanes were measured and some frequency assignments were made. (auth)

11120 PHYSICO-CHEMICAL PROPERTIES OF RARE-EARTH OXIDES. L. G. Ganichenko, N. D. Topor, and K. V. Topchieva. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 19-25 (July-Aug. 1964). (In Russian)

Preparations were made for study by heating of the high-purity commercial oxides of La, Nd, Sm, Ho, Er, and Yb. The specific surface area (7 m^2/g) was increased for Nd oxide, for example, to 38 m^2/g by heating for 4 hr at 500 to 600°C. The release of nitrogen oxides during the heating indicated the presence of nitrate impurities. Oxygen was not released, which is explained by the fact that Nd has only one valence (+3). Heating curves for the oxides of all six metals, which are similar, are presented. (IIC-M.G.)

11121 PREPARATION OF AMORPHOUS URANIUM TRIOXIDE BY THERMAL DECOMPOSITION OF URANIUM PEROXIDE DIHYDRATE. L. M. Vidavskii, N. I. Byakhova, V. Yu. Koval'chuk, and E. A. Ippolitova. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 33-4(July-Aug. 1964). (In Russian)

Amorphous UO_3 was made by heating uranium peroxide dihydrate in a current of oxygen in a rotating furnace. At 410 to 415°C, 170 hours were required for 100% conversion. (IIC-M.G.)

11122 REACTIONS OF URANIUM TETRACHLORIDE WITH CERTAIN SCHIFF'S BASES. A. V. Lapitskii, V. P. Vizgin, and L. N. Pankratova. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 39-44(July-Aug. 1964). (In Russian)

Absorption spectra determined for the systems UCl_4-salicylaliminobenzol (SIB) and UCl_4-salicylal-o-iminophenol (SOIF) in methanol are shown. Optical density measurements were made at 370 mμ for UCl_4-SIB and at 410 mμ for UCl_4-SIOB molar absorptive coefficients σ dissociation constants for the complexes were calculated. (IIC-M.G.)

11123 A GENERALIZED EFFECTIVE SPIN-HAMILTONIAN. Fu-cheng Lin, Ji-kang Zhu, and Wu-han Huang. Wu Li Hsueh Pao, 20: 1114-23(Nov. 1964). (In Chinese)

A generalized effective spin-hamiltonian $\mathcal{H}_{SG}$ describing the EPR of transition group ions in crystals is proposed on the basis of group theory. In this method, $\mathcal{H}_{SG}$ is considered strictly by the space-time symmetry. In the first order perturbation, the irreducible spin tensors T_{LM} (L = 0, 1, . . . , 2S) describe completely the EPR of paramagnetic ions with ground state having (2S + 1) energy levels. Irreducible tensors in several point-group symmetries are presented for convenience of obtaining $\mathcal{H}_{SG}$ explicitly. Such a $\mathcal{H}_{SG}$ is equivalent to the Koster-Statz matrix. (auth)

11124 COMBINED RESONANCE IN CRYSTALS IN INHOMOGENEOUS MAGNETIC FIELDS. S. I. Pekar and E. I. Rashba (Inst. of Semiconductors, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1927-32 (Nov. 1964). (In Russian)

A new type of combined resonance is considered which arises in inhomogeneous static magnetic fields. Spatial inhomogeneity of the magnetic field results in a mixing of motions with respect to coordinate and spin degrees of freedom. This in turn leads to spin transitions induced by the electric component of the high frequency electromagnetic field. The intensity of combined resonance due to macroscopic inhomogeneity of the magnetic field or to micro-inhomogeneity of the spontaneous field in ferro- and antiferromagnetics is calculated. It is shown that in both cases combined resonance may be much more intense than paramagnetic resonance. Concurrently, the conductivity electron hamiltonian containing a periodic electrostatic potential and periodic spontaneous magnetic microfield is transformed into the effective mass hamiltonian which contaihs two different mean homogeneous magnetic fields. One of the fields is identical with the induction and acts on the orbital motion of the electron and the other appears in the spin term of the hamiltonian and itself depends on the electron Bloch functions. (auth)

11125 RARE EARTH MONOSILICIDES AND THEIR CRYSTALLINE STRUCTURE. E. I. Gladyshevskii and P. I. Kripyakevich (L'vov State Univ.). Zh. Strukt. Khim., 5: 853-9(Nov.-Dec. 1964). (In Russian)

The existence of CeSi (FeB type) and YSi (CrB type) compounds and other rare earth monosilicides was confirmed and their crystalline structure was determined. Constant lattices of FeB type compounds (LaSi, PrSi, NdSi, SmSi, GdSi, TbSi, DySi, and HoSi) and of CrB type (EuSi, ErSi, TmSi, YbSi, and LuSi) were analyzed and rare earth silicides with α-$GdSi_2$ ($TbSi_2$) structure, U_3Si_2 (La_3Li_2, Ce_3Si_2, Pr_3Si_2), and Mn_5Si_3 (Gd_5Si_3, Tb_5Si_3, Dy_5Si_3, Ho_5Si_3, Er_5Si_3, Tm_5Si_3, Yb_5Si_3, and Lw_5Si_3) were found. (R.V.J.)

11126 NUCLEAR QUADRUPOLE RESONANCE SPECTRA OF ^{35}Cl AND ^{79}Br IN C_6X_5Y TYPE BENZENE HALIDE DERIVATIVES. G. K. Semin, V. I. Robas, L. S. Kobrina, and G. G. Yakobson (Inst. of Organic Compounds, Academy of Sciences, USSR and Inst. of Organic Chemistry, Academy of Sciences, Siberian SSR). Zh. Strukt. Khim., 5: 915-18 (Nov.-Dec. 1964). (In Russian)

Nuclear quadrupole resonance spectra of ^{35}Cl in C_6Cl_5Y type compounds (Y = $N(CH_3)_2$, $NHCH_3$, NH_2, H, SCH_3, SH, OCH_3, OH, COOH, COCl, Br, and F) were found at 77°K, and a visual presentation is given of the mean nuclear quadrupole resonance frequencies of ^{35}Cl in C_6Cl_5Y compounds. Nuclear quadrupole resonance spectra of ^{79}Br in C_6Br_5Y type compounds at 77°K were also found. (R.V.J.)

11127 DEFECTS IN IONIC CRYSTALS. F. Seitz (Univ. of Illinois, Urbana). p.362-77 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The presence of point defects in uncolored alkali halide crystals and their effects on electric conductivity are discussed. Diffusion of normal ions and divalent impurity ions in the crystals is also treated. The electron excess centers in alkali halides (F-centers and M-centers) and their effects are described. Hole excess centers are also considered. (M.C.G.)

11128 FORMATION AND MOTION OF DEFECTS IN IONIC CRYSTALS. R. Smoluchowski (Princeton Univ., N. J.). p.378-85 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The origin and motion of lattice defects in ionic crystals is discussed. The problem of converting ionization energy into a kinetic energy of ions necessary to produce a displacement is considered. De-excitation collision mechanisms of energy conversion were concluded to be the most probable. The stability of H-centers is discussed. (M.C.G.)

11129 ELECTRON DIFFRACTION IMAGE FORMATION IN THE ELECTRON MICROSCOPE. R. Gevers (S.C.K.-C.E.N., Mol, Belg.). p.471-533 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Fundamentals in the theory of diffraction contrast for electron microscopy are discussed. The amplitudes of the waves transmitted and scattered by a perfect foil were calculated. It is shown how the presence of defects can be taken into account. Stacking faults, dislocations, small precipitates, and fission track parallel to the surface are considered. (M.C.G.)

11130 DIFFUSION IN THE SOLID STATE. A. B. Lidiard (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.804-16 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Diffusion in solids is discussed. Interstitial atoms, substitutional impurities, and their diffusion are considered. Correlation effects for diffusion coefficients are discussed. The influence of solutes on diffusion is described. Use of isotope effects to study interactions between solute atoms and vacancies is suggested. Thermodynamic formulation of solid-state diffusion processes is given. (M.C.G.)

11131 ON THE STRUCTURE AND PROPERTIES OF STRONTIUM ZIRCONATE. STUDY OF THE EQUILIBRIUM DIAGRAM OF ZrO_2–SrO. EXTENSION OF THE STUDY TO OTHER SYSTEMS MO_2–M'O. M. Perez y Jorba, G. Tilloca, and R. Collongues (Centre National de Recherches Scientifiques, Vitry-sur-Seine, France). 10p. (CONF-640701-10). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The methods of preparation, structure, and principal physico-chemical properties of strontium zirconate $SrZrO_3$ were studied. Some characteristics of the equilibrium diagram ZrO_2–SrO are reported. Data on homologous compounds with a thoria base are given. (J.S.R.)

11132 IONIC CONDUCTIVITY AND VACANCY ORDERING IN CALCIA STABILIZED ZIRCONIA. R. E. Carter and W. L. Roth (Knolls Atomic Power Lab., Schenectady, N. Y.). 27p. (CONF-640702-1).

From American Crystallographic Assn. Annual Meeting, Bozeman, Mont.

The conductivity of calcia-stabilized zirconia is first increased and then decreased by increasing the calcia or oxygen vacancy concentration. The conductivity is also decreased by annealing below a composition dependent temperature. The structure of stabilized zirconia determined from polycrystalline neutron diffraction analysis is consistent with an anion deficient fluorite model and inconsistent with a cation interstitial model. All of the neutron diffraction patterns also show strong diffuse scattering indicative of short-range order. The low-temperature annealing which decreases the conductivity resolves the diffuse neutron scattering from 16 and 19 mole % CaO material into new but different peaks, while no change is observed in 13 mole % material. Thus one and possibly two new phases exist in the high calcia region. Normal exposure x-ray patterns from both annealed and unannealed single crystals show only the reflections of a fluorite arrangement. Long exposures reveal a complex diffuse pattern of spots, arcs, and rods, owing to small ordered regions of a pre-precipitate which are epitaxially related to the host lattice. To date, efforts to observe this precipitate with the electron microscope were unsuccessful. (auth)

11133 THE PRODUCTION OF SUPER OXYGENATED AIR BY LIQUEFACTION. H. Grenier (Air Liquide, Champigny, France). 8p. (CONF-640701-35). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The separation of air into its constituents for the purpose of producing oxygen of the desired enrichment and the compression of enriched oxygen are discussed. The theoretical aspects and the actual results obtained in two procedures for the production of oxygen of the desired purity are described. The energy consumption in the compression is calculated as a function of the enrichment. (J.S.R.)

11134 SIMULTANEOUS ABSORPTION OF TWO GASES IN A REACTIVE LIQUID. L. A. Goettler and R. L. Pigford (Univ. of Delaware, Newark). New York, American Inst. of Chemical Engineers, 1964, Preprint 25e, 32p, $0.50. (CONF-641201-11)

From American Institute of Chemical Engineers Annual Meeting, Boston.

Penetration theory equations describing the simultaneous absorption of two gases into a reactive liquid were solved numerically by a finite difference technique. Two additional parameters representing the ratios of the interfacial concentrations and the reaction rate constants of the two absorbed gases must be specified when the reactions proceed at a finite rate. For certain values of these two parameters the average absorption rate of one gas becomes higher than that for infinitely fast chemical reactions. Whenever the rate constants of the two gases are not equal, longer contact times are required to approach the absorption rates for infinitely fast reactions. Solutions for different diffusivity ratios and total gas concentrations that approach the same absorption rate for infinitely fast reactions may not agree when the reaction rates are finite. (auth)

11135 THE ELECTROTHERMAL FLUIDIZED BED: PERFORMANCE AND FIELDS OF APPLICATION. W. M. Goldberger, J. E. Hanway, Jr., and B. G. Langston (Battelle Memorial Inst., Columbus, Ohio). New York, American Inst. of Chemical Engineers, 1964, Preprint 30b, 43p, $0.50. (CONF-641201-8)

From American Institute of Chemical Engineers Annual Meeting, Boston.

The electrothermal fluidized bed was studied and developed to the point where it can be considered a reliable production tool in many process applications. Its advantages from a fluidized-solids standpoint, coupled with the utility provided by direct heating of the bed to high temperatures are discussed. The characteristic features of the fluidized bed, such as excellent temperature control, high heat and mass transfer rates, and continuity of operation, can be used to advantage in numerous electrothermal processes. Electric furnace operations, for example, can be updated by electrothermal fluidized-bed methods, and applications are being developed in all phases of chemical and metallurgical practice. (auth)

11136 ROTATION OF AMMONIUM IONS IN SOLID SOLUTIONS. K. Mikke and L. Dobrzynski (Inst. of Nuclear Research, Swierk, Poland). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/31, 10p. (CONF-804-12)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

As was previously shown by Mikke and Kroh, pure NH_4I, studied by means of inelastic scattering of neutrons, shows at liquid nitrogen temperature a sharp peak which is connected with the hindered rotation of ammonium ions and a broad distribution at room temperature attributed to free rotation. In order to study how these motions depend on the ammonium ion-ion interaction, the energy distribution of initially monochromatic neutrons scattered inelastically at 90° from solid solutions of ammonium iodide in potassium iodide were measured by the inverted filter method. Measurements were made at room and liquid nitrogen temperature for two samples of concentrations of about 17 to 25% NH_4I in KI. For these samples both in room and liquid nitrogen temperature no peaks were observed, indicating that ammonium ions rotate freely in these solutions. The analysis of these results shows that the sharp peak observed at liquid nitrogen temperature for pure NH_4I is due to a strong ammonium ion-ion interaction and suggests that the broad peak occurring at room temperature for pure NH_4I is connected with a torsional oscillation perpendicular to the rotations axis of the $N-H\cdots I^-$ in accordance with the model proposed by Vedder and Hornig. The results are compared with Krieger-Nelkin theory. A model of simultaneously existing different types of rotation is proposed. (auth)

11137 INDICATION OF PROTON TUNNELING IN KH_2PO_4 FROM A COMPARISON OF NEUTRON INELASTIC SCATTERING AND INFRARED MEASUREMENTS. I. Pelah, E. Wiener, and J. Imry (Israel Atomic Energy Commission, Yavne). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/26, 9p. (CONF-804-17)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Proton motions will show up predominantly in the spectra of neutron inelastic scattering because of its high cross section. Infrared absorption, on the other hand, will indicate only the modes allowed by selection rules. Therefore, the motions of the proton and their characteristics can sometimes be determined by comparing the results of the two techniques. The spectra of KH_2PO_4 in the region from 200 to 700 cm^{-1} are similar in both methods; two rather sharp lines are observed at 540 cm^{-1} and 410 cm^{-1} that are PO_4^{3-} characteristic modes. On the other hand, in KH_2PO_4 two peaks are observed in infrared absorption—a sharp one at 540 cm^{-1} and a very broad one from 450 to 250 cm^{-1}. In the neutron inelastic scattering spectra, only one broad peak is observed, extending from 600 to 250 cm^{-1}. These results lead to the conclusion that the proton is involved also in modes of vibrations that are not characteristic to PO_4^{3-} group and that these low proton frequency modes are prohibited by infrared selection rules. Low proton modes of this type can be explained as being caused by proton motion in a slightly asymmetric double minima potential. The vibrational ground level of the proton is then split into two closely lying levels with a separation of about 400 cm^{-1}. The wave functions of the lower level are concentrated in the deeper well while those of the higher level are concentrated in the upper well. Infrared selection rules predict low intensity to this mode in infrared absorption but it will show up clearly in neutron inelastic scattering. The assumption of proton tunneling in KH_2PO_4 type crystals, which is strongly supported by the results of this work, leads to an explanation of phase transition on these materials, namely the ferro-electric Curie point and melting point. (auth)

11138 IMPROVEMENTS IN SOLS CONTAINING ACTINIDE METALS. (to W. R. Grace and Co.). British Patent 973,839. Oct. 28, 1964. Priority date Feb. 27, 1962, United States.

A method for preparing sols of particles consisting of an intimate mixture of HfO_2 or ZrO_2 and an oxide of a quadrivalent actinide metal (U and the metals of atomic number greater than U) is described. The sols can be prepared by autoclaving (1) a freshly prepared solution of HfO_2 or ZrO_2 or a solution of a salt of Hf or Zr with a non-oxidizing acid with (2) a freshly prepared sol of the actinide metal oxide or a solution of a salt of the actinide metal with a non-oxidizing acid in a N_2 atmosphere for about 20 hours at 100–200°C. The sols thus prepared contain less than 40 mole % HfO_2 or ZrO_2, consist of an intimate mixture of ZrO_2 and UO_2, and have a particle size of 10–120mμ in diameter. These sols can be incorporated into ceramic type fuel elements, and certain of the actinide oxide type fuels are stabilized by the ZrO_2. (A.G.W.)

11139 METHOD OF PRODUCING BORON HYDRIDES. Lodovico Avogadro di Cerrione (to MONTECATINI). German Patent 1,173,881. July 16, 1964. Priority date July 6, 1960, Italy.

Boron hydrides are produced by reacting boron halides with metallic boron hydrides in the presence of an inert, liquid, organic medium using metal halides as catalyzers. The invention is characterized in that sodium or potassium hydride is transformed in a hydrocarbon at a temperature of at least 50°C and in the presence of aluminium chloride. (auth)

11140 STRONTIUM COMPOSITION AND PROCESS OF MAKING IT. Lawrence C. Amos (to U. S. Atomic Energy Commission). U. S. Patent 3,165,475. Jan. 12, 1965.

The oxide or carbonate of ^{90}Sr is converted to a practically water-insoluble, acid-soluble compound by reaction with LiF at above 800°C. (AEC)

11141 CARBON BODY TREATMENT. Geoffrey R. Tully, Jr. and Bryon Disselhorst (to U. S. Atomic Energy Commission). U. S. Patent 3,167,447. Jan. 26, 1965.

A method is described for sealing a C body in a manner which avoids the development of cracks and other flaws in the body. The method comprises either impregnating the C body in a way which selectively fills some but not all of the pores of the body, or filling all the pores with impregnant and thereafter removing the impregnant from a small portion of the pores in order that gases may be expelled from the body during subsequent curing and carbonizing steps, and thereafter repeating the partial impregnating, curing, and carbonizing steps a sufficient number of times to progressively reduce the permeability of the C body the desired amount. (AEC)

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Refer also to abstracts 10908 and 10909.

11142 ^{35}S LABELING AND CHEMICAL CONVERSIONS ON A SIDE CHAIN OF PHALLOIDIN. Theodor Wieland and Dietrich Rehbinder (Universität, Frankfurt am Main). Ann. Chem., 670: 149-57(1963). (In German)

Two ^{35}S-containing poisonous bicyclopeptides were prepared from phalloidin. Phalloidin was converted to ketophalloidin by $NaIO_4$ oxidation by a procedure similar to that of Wieland and Schoepf (Ann. Chem., 626: 174(1959)). This was converted to the dithiolan; a preparation using ethanedithiol-1,2-^{35}S is alternately described. The latter was prepared as follows: $Ba^{35}SO_4$ was precipitated from an aqueous solution of $Na_2{}^{35}SO_4$ and inactive Na_2SO_4. The precipitate was either reduced with H_2 at 900°C in a quartz vessel or else with excess K to BaS or K_2S. H_2S-^{35}S was generated by slow dropping of dilute HCl on the sulfide under N_2, dried with $CaCl_2$ and led into the calculated amount of ca. 0.3M alcoholic KOH or NaOH solution. To 1 ml of this KHS-^{35}S solution at 45°C, 0.09 ml ethylene bromide was added with stirring. After 4 hours' agitation at 45°C, a threefold excess of water is added and extracted several times with ether. After drying the ether with Na_2SO_4, it is evaporated with N_2, and the residual oil taken up in 0.5 ml methanol. This was used to prepare the dithiolan (6×10^{-3} μC/μg) in methanol saturated with HCl; the product was precipitated with ether and purified by crystallization from methanol-water. The second compound, δ-mercaptophalloin disulfide (4×10^{-2} μC/μg), was prepared from the tosylate of phalloidin (δ-tosylphalloidin) in methanol at 35°C for 1 hour. This was precipitated by addition of ether and chromatographed on cellulose. Hydrolytic reactions are described. (BBB)

11143 CARBON-14 AND TRITIUM-LABELED DPN AND TPN. Sterling Chaykin (Univ. of California, Davis). Atomlight, No. 43, 1-8(Jan. 1965).

It was found that DPN-^{14}C and TPN-^{14}C (diphosphate pyridine nucleotide and triphosphate pyridine nucleotide) can simultaneously be prepared from nicotinamide-7-^{14}C with the assistance of S. fragilis C_{351} in yields up to 16 and 42%, respectively. DPN-^{14}C can be prepared, which has a specific activity essentially equal to that of the nicotinamide-^{14}C used in its preparation. Tritium-labeled DPN, labeled in the 2, 4, and 6 positions of the nicotinamide ring can be prepared from the "reduced-DPNs" produced on the reduction of DPN by tritium-labeled sodium borohydride. A variety of labeling patterns are possible varying from a single site labeled, to all three labeled. These tritium-labeled DPNs can have specific activities as high as a quarter of a curie per mmole. (auth)

11144 SYNTHESIS OF IODINE-131 LABELED COMPOUND BY FISSION RECOIL METHOD. Teng-yueh Chen and Si-jung Yeh (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 65-7(Feb. 1964).

The preparation of $CH_3{}^{131}I$ by neutron irradiation of mixtures of U_3O_8 and ammonium acetate with subsequent separation of the product by distillation after dissolution of the recoil medium in absolute alcohol was investigated. The yields were found to improve as the weight ratios of ammonium acetate/U_3O_8 increased. The average yield was about 40%. (D.C.W.)

11145 STEAM AND HEAT SETTING OF NYLON 6 FIBER. VII. INFRARED SPECTRA OF NYLON 6 PREPARED FROM N-DEUTERATED ε-CAPROLACTAM AND THE WATER ACCESSIBILITY OF NYLON 6 IN STEAM

SETTING. A. Koshimo (Nippon Rayon Co., Ltd., Kyoto). J. Appl. Polymer Sci., 9: 55-68(Jan. 1965).

The infrared spectrum of deuterated ϵ-caprolactam was examined. It was confirmed spectroscopically that the hydrogen of the N−H group in ϵ-caprolactam is exchanged for deuterium after repeated exchange reactions. The deuterated ϵ-caprolactam was polymerized, and the infrared spectrum of the polymer (called as N−D polymer) is compared with that of the normal nylon 6 polymer (called N−H polymer), which was steam-set in D_2O vapor at 135°C. Characteristic absorption bands of N−D polymer were observed at 967, 896, 888, 876, and 719 cm^{-1}. The water accessibility of both N−N and N−D polymer was estimated from the spectra of both samples subjected to repeated steam setting in D_2O and H_2O alternately at 130°C. The results showed that at the initial stage of the repeated steam setting, H_2O and D_2O molecules may penetrate into the ordered regions in the polymers and partially break down intermolecular hydrogen bonds; such phenomenon may be followed by an exchange reaction and recrystallization. Subsequent stages of steam setting, however, no longer bring about such an effect. (auth)

11146 STEAM AND HEAT SETTING OF NYLON 6 FIBER. IX. CHANGES IN INFRARED SPECTRA WITH DEUTERATION OF HEAT-SET NYLON 6. A. Koshimo (Nippon Rayon Co., Ltd., Kyoto). J. Appl. Polymer Sci., 9: 81-90(Jan. 1965).

The degree of crystallinity of nylon 6 was increased by both steam and dry heat setting, while the diffusion rate of dyes was increased by steam setting and decreased by dry heat setting. These phenomena were previously explained in connection with the state of the amorphous regions. This explanation was confirmed by a quantitative analysis of infrared spectra. Heat-set nylon 6 films were deuterated with D_2O at 60°C, for 100 hr in the vapor phase. Integral intensities of N−D stretching vibration band on the spectra were calculated from the equation: $[1/(1-\alpha)l] \int \log (I_0/I)d\nu = K'C$, where I_0 and I are the intensity of the incident and the transmitted light respectively, l the thickness, and α the degree of crystallinity. K'C represents the number of free N−H groups in the amorphous fraction. The value K'C was increased by steam setting and decreased by dry heat setting. (auth)

11147 INVESTIGATION OF THE FINE STRUCTURE OF HIGH POLYMERS BY THE METHOD OF DEUTERIUM EXCHANGE. I. CHANGES IN LATERAL-ORDER DISTRIBUTION OF NYLON 6 BY HEAT SETTING. A. Koshimo and T. Tagawa (Nippon Rayon Co., Ltd., Kyoto). J. Appl. Polymer Sci., 9: 117-28(Jan. 1965).

The lateral-order distribution of nylon 6 was evaluated by deuteration and infrared spectroscopic measurement. Unset, dry-heat-set, and steam-set samples were placed in contact with D_2O vapor at various temperatures from 25 to 150°C. After equilibrium of the reaction was attained, they were dried and sealed in a NaCl cell. The ratio of the intensity of N−D to C−H vibration bands in the 3 to 4 μ region was calculated from the infrared spectra and plotted against temperature of deuteration. The curves obtained showed the accessibility of the sample to D_2O vapor at various temperatures, and the differential of the curve gives the lateral-order distributions of nylon 6. The lateral-order distribution showed that regions of amorphous and of intermediate order decrease, and regions of higher and crystalline increase on dry heat setting, while regions of intermediate order markedly decrease and amorphous and crystalline regions increase on steam setting. These phenomena suggest that loosening of polymer molecules in the amorphous regions and crystallization are caused by the steam setting. (auth)

11148 SECONDARY IONS IN THE MASS SPECTRUM OF PROPANE. Keith R. Ryan and Jean H. Futrell (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Chem. Phys., 42: 819-23(Feb. 1, 1965).

The secondary spectra arising from ionic reactions in propane at several mean ion energies are reported. The results were compared with computed values taken from results obtained by techniques developed by Lindholm. From the comparison a calculation was made for the secondary spectrum obtained by bombarding C_3H_8 with $C_2H_4^+$ ions. Experiments using mixtures of C_2D_4 and C_3H_8 led to an observed secondary-ion spectrum, which was in good agreement with that calculated. A significant number of ionic fragments in the secondary spectrum appeared to be formed by endothermic processes. It was assumed that translational energy supplies the required energy. Some appearance-potential measurements support this assumption. There appeared to be some evidence for CH_3^- transfer when C_3H_8 is bombarded either by $C_2H_3^+$ or $C_2H_4^+$. In both cases there was also a competing H^- transfer process. (auth)

11149 ELECTRON DIFFRACTION STUDY OF THE STRUCTURES OF ETHANE AND DEUTEROETHANE. L. S. Bartell and H. K. Higginbotham (Iowa State Univ., Ames). J. Chem. Phys., 42: 851-6(Feb. 1, 1065).

An electron diffraction structure determination for ethane and deuteroethane was carried out to study the magnitudes of primary and secondary deuterium isotope effects on bond lengths. Mean parameters and estimated standard errors for C_2H_6 were $r_g(C-H) = 1.1122 \pm 0.0012$, $l_g(C-H) = 0.0760 \pm 0.0010$, $r_g(C-C) = 1.5340 \pm 0.0011$, and $l_g(C-C) = 0.0496 \pm 0.0010$ Å, and $\angle CCH = 111.0 \pm 0.2°$. Corresponding parameters for C_2D_6 were $r_g(C-D) = 1.1071 \pm 0.0012$, $l_g(C-D) = 0.0668 \pm 0.0010$, $r_g(C-C) = 1.5323 \pm 0.0011$, and $l_g(C-C) = 0.0517 \pm 0.0010$ Å and $\angle CCD = 111.0 \pm 0.2°$. Shrinkage corrections were not made for bond angles. A primary deuterium isotope effect of 0.0050 ± 0.0006 Å was found for the carbon-hydrogen bond. A possibly significant secondary effect was observed in which the C−C length in ethane exceeded that in deuteroethane by $\Delta r_g(1) = 0.0016 \pm 0.0007$ Å. Some aspects of secondary isotope effects are discussed briefly. (auth)

11150 ELECTRON DIFFRACTION STUDY OF CH_3NH_2 AND CD_3ND_2. H. K. Higginbotham and L. S. Bartell (Iowa State Univ., Ames). J. Chem. Phys., 42: 1131-2(Feb. 1, 1965).

The effects of deuterium substitution on bond lengths in methylamine were studied. A normal primary isotopic shift was observed for the composite C−H, N−H radial distribution peak, but insufficient precision was attained to detect a secondary isotope effect in the C−N distance. However, the resultant C−N single bond length appeared to be several-fold more accurate than previously reported values. (M.C.G.)

11151 CARBON−HALOGEN DISTANCES IN DEUTERATED METHYL CHLORIDE AND METHYL BROMIDE. R. H. Schwendeman and J. D. Kelly (Michigan State Univ., East Lansing). J. Chem. Phys., 42: 1132-4(Feb. 1, 1965).

Deuterated methyl chloride and methyl bromide, each enriched to approximately 20% in ^{13}C, were prepared. Microwave spectra of the various possible carbon and halogen isotopic species were measured. The C−Cl distance in CD_3Cl and the C−Br distance in CD_3Br were calculated. An apparent decrease of the carbon-halogen distance on deuteration of the compound was observed. Each of the $J = 0 \rightarrow 1$ transitions occurred as a multiplet of three lines due to quadrupole interaction of the over-all rotation with the spin of the halogen nucleus. (M.C.G.)

11152 ISOTOPE SHIFT IN THE PROTON MAGNETIC RESONANCE OF CH_4, CH_3D, CH_2D_2, AND CHD_3. R. A. Bernheim and B. J. Lavery (Pennsylvania State Univ., University Park). J. Chem. Phys., 42: 1464(Feb. 15, 1965).

The isotopic shift of the proton magnetic resonance in the series CH_4, CH_3D, CH_2D_2, and CHD_3 was measured. The indirect spin-spin coupling constant was the same for all species and agreed with previously measured values. Graphical presentations showed that the isotopic shift is not linear. (M.C.G.)

11153 ORGANIC DISULFIDES AND RELATED SUBSTANCES. XII. (2-AMINOETHYLDITHIO) BENZOIC ACIDS AND DERIVATIVES. R. R. Crenshaw and Lamar Field (Vanderbilt Univ., Nashville). J. Org. Chem., 30: 175-81(Jan. 1965).

Syntheses and structural evidence are reported for the ortho, meta, and para isomers of (2-aminoethyldithio)-benzoic acid and for various derivatives. The ortho isomer was protective against lethal effects of ionizing radiation, but related substances were not. The ortho isomer exists in two isomorphic forms. Efforts to cyclize the ortho isomer to the eight-membered lactam gave polymeric products, susceptible to further polymerization, suggesting that the lactam readily breaks at the disulfide bond and subsequently polymerizes. Relative resistance of the various unsymmetrical disulfides toward disproportionation into symmetrical disulfides was examined, and correlations are suggested between the degree of resistance and structural features. Preparation of aromatic thiolsulfonates using the chlorinolysis procedure developed by Douglass and Farah for aliphatic disulfides usually was effective. (auth)

11154 DEUTERATION OF PROTEINS AND POLYAMIDES IN DEUTERIUM OXIDE VAPOR. R. Jeffries (Shirley Inst., Manchester, Eng.). J. Polymer Sci., Pt. A, 2: 5161-70(Dec. 1964).

The H → D exchange reactions in proteins and polyamides immersed in saturated deuterium oxide vapor are described. Ten proteins (seven silk fibroins, wool, byssus, and Fibrolane BX) and the nylons 66, 6, and 11 were studied. With all the samples there was an initial rapid exchange followed by a slower exchange, this slow change gradually leveling off to equilibrium. The extent of the H → D exchange is discussed in relation to order and disorder in the polymer structures. The extent of exchange is shown to be related to the proportions of large side chains in the samples and also to the water sorption values. It is shown that the decrease in the absorbance of the 3300 cm^{-1} band of the polyamide films is a reasonably satisfactory measure of the extent of the H → D exchange in these films, provided that changes in band width are taken into account. (auth)

11155 DECOMPOSITION OF DIETHYLSTILBOESTROL IN SOIL. Birte Gregers-Hansen (Atomenergikommissionen, Riso, Denmark). Plant Soil, 20: 50-8(Feb. 1964).

Diethylstilbestrol (DES), a very active synthetic estrogen used to increase the growth rate of poultry, cattle, lambs, and other animals, is almost entirely excreted regardless of whether it is administered subcutaneously or orally. Consequently, the full amount of hormone administered will eventually reach the soil, and if it is not rapidly decomposed in the soil this may result in an uptake by plants which can thus present a hazard to man and animal. In experiments on decomposition of DES in soil, ^{14}C-labeled DES was added to soil samples and its decomposition studied by measuring the production of $^{14}CO_2$ from the soil. At the end of the decomposition period residual ^{14}C was extracted from the soil samples in an attempt to account for all the added DES. High-dose γ irradiation was used for distinguishing between decomposition caused by living organisms and decomposition due to enzymes present in the soil. Thus, a 2.5-Mrad dose from a ^{60}Co source was used to ensure complete sterilization, but should not greatly alter the nature of the enzyme systems present. Study of the rate of decomposition of DES-monoethyl-1-^{14}C in soil showed that from 1.6 to 16% of the added ^{14}C was recoverable as $^{14}CO_2$ during three months. After six months as much as 12 to 28% was released as $^{14}CO_2$. Determination of ^{14}C in the soil samples after the experiments showed that the amount extractable with benzene decreased to a greater extent than would be expected from the production of $^{14}CO_2$ and that the amount extractable with water was increased when compared with that found shortly after the addition of DES. Addition of large amounts of DES(8%) did not inhibit the CO_2 production from the soil. The experiments with γ-ray-sterilized soil indicated that enzymes present in the soil are able to attack DES. (BBB)

11156 VIBRATIONAL SPECTRA OF EIGHT ISOTOPIC SPECIES, VALENCE FORCE CONSTANTS AND ROTATIONAL BARRIER OF 2-CHLOROPROPENE. H. Hunziker and Hs. H. Guenthard (Eidgenossische Technische Hochschule, Zurich). Spectrochim. Acta, 21: 51-76(Jan. 1965).

Infrared spectra of the gaseous state in the region 3500 to 130 cm^{-1} were recorded for eight isotopic modifications of 2-chloropropene and Raman spectra of the liquid were photographed for two of them. Assignments based mainly on normal coordinate calculations are given for 163 of the 168 fundamentals. A 27-parameter valence force field was computed from 127 fundamental frequencies by an iterative process. The barrier heights of internal rotation as calculated by the usual semirigid model approximation were different for CH_3- and CD_3-groups. However, it is shown that large systematic errors in the barrier determination are introduced by neglecting the interactions between the torsional motion and other vibrations of the same symmetry. (auth)

11157 ISOTOPE EFFECTS IN PROTON TRANSFERS FROM 2-NITROPROPANE. Lance Harmon Funderburk. Thesis, Houston, Tex., Rice Univ., 1964. 69p.

Hydrogen isotope effects were determined in the acid-catalyzed bromination of α-methyldesoxybenzoin and the base-catalyzed iodination of 2-nitropropane. For the bromination of α-methyldesoxybenzoin, values of 8.39 and 10.6 were obtained for k_H/k_D and k_H/k_T, respectively. These values disagree considerably with an equation (Swain et al., J. Am. Chem. Soc., 80: 5885 (1958)), derived by assuming that isotope effects arise only from differences between the zero-point energies of the reactants and the transition state. This disagreement can be explained by tunneling through the potential barrier. The rates of iodination of 2-nitropropane were determined in 60% aqueous t-butanol with methylpyridines as catalysts. Values for $\overline{k_H}/k_D$ increased with the base strength of the catalysts and with α-methyl substitution on the pyridine ring. The increase of k_H/k_D with base strength indicates that the symmetry of the "symmetrical" stretch of the transition state is affected. The very large isotope effects can only be explained by including a large tunneling correction in the usual absolute reaction rate theory of isotope effects. The increase of k_H/k_D with substitution in the α-positions of the pyridine ring indicates that steric inhibition of the reaction changes the energy barrier so as to increase the probability of tunneling. (Dissertation Abstr., 25: No. 3, Sept. 1964)

11158 ION-MOLECULE REACTIONS IN COMBUSTION PLASMAS AND ATOMIC DIFFUSION FLAMES. W. J. Miller, H. F. Calcote, and A. Fontijn (AeroChem Research Labs., Inc., Princeton, N. J.). 20p. (CONF-649-14)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

Premixed hydrocarbon-oxygen flames and low-temperature atomic diffusion flames (resulting from the reaction of oxygen atoms with hydrocarbon) have been examined mass spectrometrically for both positive and negative ion content. The results indicate that two separate primary chemi-ionization reactions are operative in both systems, namely: CH (or CH*) + O → CH^+ + e and CH* + C_2H_2 → $C_3H_3^+$ + e. Individual positive ion profiles are interpreted in terms of secondary ion formation mechanisms. Among the reactions found plausible are: $CH_2O + CHO^+ \rightarrow CH_2OH^+ + CO$; $CH_3OH + CHO^+ \rightarrow CH_3OH_2^+ + CO$; $C_2H_2O + CHO^+ \rightarrow C_2H_3O^+ + CO$; $CH_3CHO + CHO^+ \rightarrow CH_3CHOH^+ + CO$. Negative ions have been found in premixed combustion flames in concentrations on the order of 10^{-9} mole fraction; the ions observed include O^-, OH^-, C_2^-, and O_2^-. These ions are thought to arise from dissociative attachment processes involving carbon-containing species. The first negative ion formed in these reactions is almost surely C_2^-, which is thought to arise from $e^- + C_2H_2O \rightarrow C_2^- + H_2O$. Negative ions have also been found in the cool atomic diffusion flames and at maximum concentrations are approximately equal to the positive ion concentration. Several ions have been identified in this system. (auth)

Radiation Chemistry

Refer also to abstracts 11332 and 11502.

11159 (AERE-R-4332) THE EFFECTS OF WATER VAPOUR, CARBON MONOXIDE AND PORE VOLUME ON

THE RADIOLYTIC REACTION BETWEEN CARBON DIOXIDE AND GRAPHITE IN SEALED TUBES. PART I. THE ADDITION OF WATER VAPOUR TO CO_2 AND CO/CO_2 MIXTURES. F. S. Feates, A. G. Poole, M. Tomlinson, R. J. Waite (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). PART II. THE EFFECT OF PRE-IRRADIATION OF GRAPHITE IN CARBON MONOXIDE/CARBON DIOXIDE MIXTURES. N. J. Cluley, and N. S. Corney (General Electric Co., Ltd. Research Labs., Wembley, England). Dec. 1964. 32p. Dep.; $1.00(BIS), 5s.(HMSO).

Irradiations have been conducted in sealed tubes at gas pressures up to 25 atmospheres and at a temperature of 180°C to test the influence of water vapor on the radiolytic gasification of graphite in a CO_2 or CO/CO_2 atmosphere. Within the limits of experimental error (±10%), no effect of water vapor at concentrations up to 1.7 vol % has been detected for a reactor radiation dose of about 100 ev/molecule gas. A large effect of pore volume of graphite powders on G(CO) and G(−C) was observed at pressures up to 25 atmospheres. The effectiveness of dry carbon monoxide in "protecting" graphite from subsequent gasification in carbon monoxide/carbon dioxide mixtures has also been investigated in sealed tube experiments. No evidence for protection was found. (auth)

11160 (AERE-R-4659) THE RADIOLYTIC REACTION BETWEEN GRAPHITE AND CARBON DIOXIDE. GAS FLOW EXPERIMENTS. PART II. EFFECTS OF PRESSURE, TEMPERATURE AND GAS FLOW RATE. F. S. Feates and F. A. Walker (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1964. 51p. Dep.; $1.40(BIS), 7s.(HMSO).

Experiments in which gas flow rates are varied are used to estimate apparatus constants for the equipment employed. Methods are shown for the determination of initial values of G(CO) and G(−C). G(−C) is slightly pressure sensitive, passing through a maximum value at about 10 atmospheres pressure. It is also sensitive to temperatures above 300°C, rising by a factor of 2 as the temperature is raised from 300 to 500°C. The heterogeneous steps in the gasification of graphite by irradiated carbon dioxide are considered and a mechanism involving the participation of radiolytically generated surface oxides is proposed. An oxidizing agent, tentatively identified as ozone, is evolved from a stainless steel in-reactor apparatus. Neon-23 has been detected as a radioactive impurity in the effluent from the apparatus. (auth)

11161 (AERE-R-4817) THE RADIOLYTIC REACTION BETWEEN GRAPHITE AND CARBON DIOXIDE. PART IV. GAS FLOW EXPERIMENTS IN DIDO: THE EFFECT OF METHANE. D. A. Dominey and H. Morley (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1964. 24p. Dep.; $0.60(BIS), 3s.(HMSO).

The in-reactor apparatus consists of a calorimeter and two stainless steel capsules containing graphite samples, one of which is labelled with ^{14}C. The capsules are supplied with independent capillary leads to in-line analytical apparatus consisting of a scintillation counter, a water meter, an I.R.G.A. and an automatic sampling gas chromatograph which also records the ^{14}C content of each component of the gas. The rate of ^{14}C evolution in pure CO_2 has been compared with that in mixtures of CO_2 with 1% CO and up to 0.2% CH_4, and the effects of variation of flow rate, dose rate, temperature, and pressure on the reduction of oxidation rate have been studied. The results suggest that the agent responsible for protecting the graphite from oxidation is a short-lived product of the radiolysis of $CO/CO_2/CH_4$ mixtures and that this agent interferes in some way with processes occurring at the graphite surface. An experiment using $^{14}CH_4$ showed that carbon which is deposited in some form during the period in which oxidation was reduced was slowly removed while the normal oxidation rate in CO_2 was being re-established. (auth)

11162 (AERE-R-4819) THE RADIOLYTIC REACTION BETWEEN GRAPHITE AND CARBON DIOXIDE GAS FLOW EXPERIMENTS. PART III. SURFACE COMPLEXES AND TRANSIENT EFFECTS. F. S. Feates and J. R. Parry (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1964. 29p. Dep.; $0.90(BIS), 4s. 6d.(HMSO).

Improved equipment is described for studying the reaction between radiolysed carbon dioxide and graphite in BEPO. The results reported in Parts I and II have been extended with this equipment and are reported in outline. The formation on the graphite of surface complexes which can be decomposed thermally and which play an important part in the gasification reaction has been confirmed. The effect of methane on the gasification rate is unexpectedly small and this is believed to be associated with the absence of ozone from the effluent gas from this equipment when experiments are conducted in pure CO_2. Transient behavior on changing apparatus parameters are interpreted in terms of surface adsorption processes. (auth)

11163 (AERE-R-4828) THE EFFECTS OF CARBON STRUCTURE ON THE RATE OF OXIDATION OF C-14 LABELLED CARBONS BY IRRADIATED CARBON DIOXIDE. F. S. Feates and A. G. Poole (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1965. 14p. Dep.; $0.50(BIS), 2s. 6d.(HMSO).

A wide variety of C^{14}-labeled carbons (varying from a high surface area carbon black to pyrographite) have been irradiated with carbon dioxide in sealed silica tubes in nuclear reactors. Attempts have been made to eliminate effects of surface condition on the rate of oxidation, and experiments have been conducted at gas pressures of one and 30 atmospheres, and at temperatures of 120 and 250°C. Within a scatter band of about a factor of two, there is little difference in the rate of C^{14} gasification or carbon monoxide production from any of the carbons, other than a carbon black, which appears to gasify at a consistently higher rate. This is contrasted to the large differences of gasification rate obtained for the corresponding thermal reaction. (auth)

11164 (BNL-8801) Co^{60} GAMMA RADIATION INDUCED POLYMERIZATION OF ETHYLENE AT CONSTANT CONDITIONS IN A NON-FLOW SYSTEM. L. E. Kukacka, P. Colombo, J. Fontana, R. N. Chapman, and M. Steinberg (Brookhaven National Lab., Upton, N. Y.). Jan. 1965. Contract AT-30-2-GEN-16. 39p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The yield and rate of polymerization of gaseous ethylene in a ^{60}Co gamma field were determined in a 100 cc static system under constant conditions of pressure, initial temperature, and radiation intensity. The experimental conditions ranged in pressure from 170 to 1920 atm, in temperature from 20 to 200°C, and radiation intensity from 5.8×10^4 to 8.5×10^5 rads/hr. A negligibly small activation energy of 0.2 kcal/mole was determined for solid polymer formation in the temperature range 20 to 100°C and 14.5 kcal/mole for molten polymer formation in the range from 120 to 200°C. Empirical relationships for the rate of polymerization and yield for the pressure range 170 to 1360 atm and at radiation intensities between 5.8×10^4 and 8.5×10^5 rads/hr were determined. The 0.5 power dependence of the intensity on rate indicates a free radical mechanism. The 2.7 power pressure dependency is much greater than ideally expected, indicating possible steric effects. At a radiation intensity of 1.79×10^5 rads/hr, pressures above 970 atm, and temperatures above 130°C, differential rates greater than 0.3 g/liter-hr-atm, corresponding to G values greater than 1.0×10^5 molecules/100 ev, were obtained. Polymerizations leading to explosive decomposition were noted at pressures above 850 atm. (D.L.C.)

11165 (EUR-2209,e) THE MECHANISM OF MOLECULE FORMATION BY NUCLEAR FISSION AND SUBSEQUENT PROCESSES IN SOLID MIXTURES. H. J. Born (Munich. Technische Hochschule). 1964. 18p. Dep.(mn).

A treatment is presented of the problem of formation of new molecules during fission in solid mixtures, with particular attention to the formation of ruthenocenes $Ru(C_5H_5)_2$ by reaction of ^{105}Ru with ferrocene and osmocene. It is concluded that the cause of the molecule formation is the beta decay of the fission products. Some experimental results also are given on the reaction of the fission product ^{131}I with halogenated benzenes. (D.L.C.)

11166 (IA-992) TABLES OF BIMOLECULAR RATE CONSTANTS OF HYDRATED ELECTRONS, HYDROGEN ATOMS AND HYDROXYL RADICALS WITH INORGANIC AND ORGANIC COMPOUNDS. M. Anbar and P. Neta, comps. (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Oct. 1964. 31p. Dep.(mn).

Tables on the kinetic behavior of various compounds with e^-_{aq}, H, and OH radicals have been compiled. The compounds are listed in alphabetical order in two groups, inorganic and organic compounds. (auth)

11167 (NAA-SR-5198) THE EFFECT OF ADDITIVES ON RADIOLYTIC DECOMPOSITION RATE OF TERPHENYL COOLANTS. M. A. Rotheram and R. H. J. Gercke (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT(11-1)-Gen-8. 26p. Dep.; $0.50(OTS).

Eighty-six organic compounds were tested as additives to determine their effectiveness in reducing the radiolytic decomposition rate of polyphenyl coolant. Of the compounds tested, alpha-truxene, and possibly thianthrene and triphenylamine, appeared to be effective in reducing the decomposition rate. These results require further verification since under the conditions of this screening test, the possibility of obtaining spurious results is quite high. Considerations of the cost of maintaining an effective additive concentration in the coolant indicate that the use of additives will not result in a significant reduction in the coolant makeup cost. Fractions of high boilers from irradiated coolant were tested as additives; these materials had no significant effect on decomposition rate. Integral decomposition rates measured for coolant samples containing 0, 25, 50, and 100 wt % high boilers were consistent with values predicted from the present understanding of coolant decomposition kinetics. Hydrogen, at pressures up to 20 atm, had no effect on the decomposition rate of coolant containing 50 wt % high boilers or on 100 wt % high boiler samples. (auth)

11168 (NASA-TN-D-2591) MEASUREMENT OF THE EFFECTS OF FAST-NEUTRON RADIATION ON LIQUID ORTHO- AND PARA-HYDROGEN. James W. Blue and Theodore E. Fessler (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Feb. 1965. 16p. $1.00(OTS).

A fast-neutron irradiation of both equilibrium and normal liquid hydrogen was performed and analyzed for evidence of conversion. The data indicated that radiation-induced ortho- to para-hydrogen conversion occurs in liquid normal hydrogen but is less than 5×10^{-3} mole fraction for an integrated neutron flux of 5×10^{13} neutrons per square centimeter. A pronounced effect of irradiation was the destruction of superheat in the liquid-hydrogen bath surrounding the test samples. This effect caused a decrease in the temperature of the bath and thereby complicated the data analysis. (auth)

11169 (RRL-152) QUARTERLY REPORT, OCTOBER 1, 1964–DECEMBER 31, 1964. Fundamental Research No. 6041. (Mellon Inst. Radiation Research Labs. Pittsburgh). Jan. 11, 1965. Contract AT(30-1)-2310. 8p. (NYO-2310-5). Dep.(mn); $1.00(cy), 1(mn) OTS.

Some radiation chemistry studies are reported. The ESR spectrum of the CF_3 radical in several fluorocarbons is discussed. The oxidation of ferrous ions by 120-Mev carbon ions was studied. The radical distribution in the γ-radiolysis of n-hexane differs in the liquid and gas phases. The effects of high pressure on the mercury-photosensitized decomposition of cyclopropane was studied using ethylene-^{14}C scavenger and resonance radiations at 1849 and 2537 A. Some results on the gamma irradiation of ethane and methane in liquid argon at −183°C are reported. (D.L.C.)

11170 (TID-21443) APPLICATION OF FISSION-PRODUCT SOURCES IN ORGANIC RADIATION CHEMISTRY. Final Summary Report, May 1, 1959–June 30, 1964. Weldon G. Brown (Chicago. Univ.). Contract AT (11-1)-754. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Some work is reported on the development of external beta sources of ^{85}Kr in thin-wall glass bulbs. Experiments were conducted on the fixation of ^{147}Pm on Pyrex glass surfaces, and data on the leaching of the activity from a 0.6-C source by various reagents are reported. The use of nitrous oxide for dosimetry was tested by means of non-condensible gas pressure readings in nitrous acid in a glass flask containing ^{147}Pm fixed on its inner surface. Of the many metal oxides tested with benzene and D_2O for catalytic activity, only Pt and Pd oxides showed activity. The effects of gamma and ultraviolet radiations on the Pt oxide–benzene–D_2O system were studied, and it was found that irradiation of the heterogeneous mixture resulted in faster catalyst activation and exchange. Studies on the radiolysis of crystalline glycolic acid and on the isomerization of cyclopropane derivatives are discussed briefly. (D.L.C.)

11171 (TID-21576) EXPERIMENTAL EFFECTS OF PILE RADIATION ON PURE FLUOROCARBONS. T. M. Reed and J. C. Mailen (Florida. Univ., Gainesville. Engineering and Industrial Experiment Station). June 1, 1963. Contract AT(40-1)-2846. 35p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Samples of fluorocarbons were irradiated in a ^{60}Co source, in the Graphite reactor, and in the LITR reactor and then analyzed by column gas chromatography. Calculated mole fractions of the products are tabulated in the cases where the chromatographic peaks are separated. The fluorocarbons studied range from CF_4 to $C_{14}F_{30}$. C_3H_8 was studied in detail, and a proposed mechanism is given. (D.L.C.)

11172 (TID-21590) EFFECTS OF POST-IRRADIATION TREATMENT OF THE PRODUCT SPECTRUM OF THE $^{14}N(n,p)C^{14}$ REACTION IN AMMONIUM CHLORIDE. Peter E. Yankwich and Pierre J. Marteney (Illinois. Univ., Urbana. Noyes Lab. of Chemistry). [1963]. Contract [AT(11-1)-1142]. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Ammonium chloride was sublimed twice in vacuo, then pile-irradiated; afterwards, samples of target were sublimed in vacuo or in the presence of 1 cm Hg pressures of hydrogen, oxygen, or ammonia, then dissolved in water, or dilute acid or base. Radiocarbon activities associated with various species were separated by gas chromatography and estimated with a flow ionization chamber. Activities above system threshold (ca. 1% of the total) were carbon dioxide, carbon monoxide, methane, formaldehyde, formic acid, methanol, and methylamine. The activity of methylamine was about 75% of the total; all other activities were in the 2–4% range except methane with ~7%. These figures derive from a reference experiment in which sample was dissolved in water and not resublimed. Sublimation of target after irradiation, of itself, did not alter this product spectrum significantly. This observation indicates that the precursors of the products observed upon water solution enjoy considerable intrinsic stability. Sublimation in the presence of added gases does affect the product spectrum, the minor activities more than the major. The effects are consistent with the character of the added gas: oxygen reduces slightly the amount of methylamine and very markedly the amount of methanol, while increasing significantly the formaldehyde and formic acid found; a reducing atmosphere has a reverse effect of similar magnitude. The acidity of the solvent is without significant effect on the product spectrum. (auth)

11173 NONRADIATIVE ENERGY EXCHANGE FROM Gd^{3+} TO Tb^{3+} IN BORATE GLASS. A. David Pearson and G. E. Peterson (Bell Telephone Labs., Inc., Murray Hill, N. J.). Appl. Phys. Letters, 5: 222-3(Dec. 1, 1964).

Resonant energy exchange between Gd^{3+} and Tb^{3+} dis-

solved in a Calibo glass host is examined. Analysis of excitation spectra from Tb alone in host, Gd alone in host, and Tb and Gd together in host indicates that the energy transfer mechanism is nonradiative. (H.D.R.)

11174 PHOTOCHEMISTRY OF IODOURACIL. II. EFFECTS OF SULFUR COMPOUNDS, ETHANOL AND OXYGEN. W. Dean Rupp and William H. Prusoff (Yale Univ., New Haven). Biochem. Biophys. Res. Commun., 18: 158-64(Jan. 18, 1965).

The effects of mercaptoethanol, cysteamine, cystamine, and ethanol on the photoproducts obtained from the uv irradiation of iodouracil (IU) were investigated. A mechanism based on these studies was postulated that possibly explains the specific protection afforded by cysteamine and cystamine on the survival of uv irradiated T1 phage substituted with bromouracil or IU. (H.M.G.)

11175 THE CHEMICAL FATE OF RECOIL IODINE ATOMS IN IODINE–METHYL IODIDE SOLUTIONS. N. V. Klassen and A. P. Baerg (National Research Council, Ottawa). Can. J. Chem., 42: 2684-94(Dec. 1964). (NRC-8148)

The organic yield of recoil ^{126}I, produced by the 14 Mev neutron irradiation of iodine–methyl iodide solutions, was examined over iodine concentrations at 0.34 mole fraction iodine to pure methyl iodide. By correcting for exchange between I_2 and methyl iodide, the initial organic yield at very low I_2 concentrations was found to be 57%. The time for one-half of the I_2 to exchange with CH_3I was found to decrease with decreasing iodine concentration. At all I_2 concentrations the organic products containing ^{126}I consisted mainly of CH_3I and CH_2I_2. The formation of products is discussed in terms of thermal reactions, diffusion-controlled reactions in the spurs, and hot reactions. (auth)

11176 ENERGY TRANSFER IN THE RADIOLYSIS OF CYCLOPENTANE–CYCLOHEXANE MIXTURES. J. A. Stone (Atomic Energy of Canada Ltd., Chalk River Ont.). Can. J. Chem., 42: 2872-9(Dec. 1964). (AECL-2081)

Energy transfer in the radiolysis of cyclopentane–cyclohexane mixtures was studied by observing the yields of HD and D_2 obtained when small amounts of cyclohexane-d_{12} are added. Energy migration occurs from cyclopentane to cyclohexane but this transfer can be prevented by the addition of CCl_4 or I_2. The relative yields of the dimers $(C_6H_{11})_2$, $C_5H_9C_6H_{11}$, and $(C_5H_9)_2$ show that the $\cdot C_6H_{11}$ and $\cdot C_5H_9$ radicals, which are the precursors of the dimers, can abstract H atoms from the solvent and may thus change their identity. Added I_2 or CCl_4 removes the diffusing radicals, and the residual dimer yield, which is unaffected by solute, has a composition determined solely by the composition of the mixtures. The yields of cyclohexene and cyclopentene show evidence of both energy transfer and radical change of identity. (auth)

11177 RADIATION CHEMISTRY OF POTASSIUM PEROXYDISULFATE. R. L. Eager and J. F. Norris (Univ. of Saskatchewan, Saskatoon). Can. J. Chem., 42: 2913-16 (Dec. 1964).

Samples of the solid compound were irradiated with ^{60}Co γ rays after which they were dissolved in water and analyzed. Hydrolysis of the peroxydisulfate ion yields sulfate, sulfite, and hydrogen ions as well as free O_2 but the presence of some other S- containing species is also suggested. The ion yields varied with the radiation dose. (F.S.A.)

11178 IRRADIATION BY γ RAYS OF ^{60}Co OF THE SALT OF AMMONIUM HEXANITRODIPHENYLAMINE. Odette Bagno and Paul Bonet-Maury (Université de Paris, Orsay, France). Compt. Rend., 259: 2841-4(Oct. 28, 1964). (In French)

The salt of ammonium hexanitrodiphenylamine irradiated by ^{60}Co γ rays, either in phosphate buffered medium (pH 7) or in $NaHCO_3$ (pH 8.35), is discolored. The variation of optical density measured at 420 mμ is proportional to the absorbed dose as long as the hypsochrome effect is not attained. (tr-auth)

11179 RADIATION-INDUCED GRAFT-COPOLYMERIZATION OF BUTADIENE TO POLYETHYLENE AND POLYPROPYLENE. M. Kadonaga, A. Furuhashi, and M. Ono. Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku, 12: No. 11, 83-93(Nov. 1963). (In Japenese)

Samples of high density polyethylene films (0.02-, 0.05-, 0.1-, and 0.5-mm thick), low density polyethylene films (0.05- and 0.5-mm thick), and polypropylene (0.03- and 0.5-mm thick) were tested. Butadiene gas was introduced into a tube containing the sample, which was irradiated by a 4000-c ^{60}Co source at 1.3×10^4r/hr to 2.5×10^5r/hr at 0°C to 80°C for 2 to 46 hr. Next the films were washed with cyclohexane for 6 hr at 55°C and for 24 hr at room temperature, to remove the ungrafted butadiene homopolymer, and vacuum-dried at 50°C. The degree of crystallization was determined by using the x-ray-diffraction method. The structure of the graft-polybutadiene was studied from the infrared absorption spectrum. Graphs show the effects of irradiation time, dosage, temperature and structure of trunk polymer on the grafting rate. Smaller grafting for thinner films was attributed to a grafting suppression on the film surface. (OID)

11180 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO POLYVINYL ALCOHOL. X. GRAFTING OF VINYL MONOMERS TO POLY (VINYL ALCOHOL) FIBERS AND SOME MECHANICAL PROPERTIES OF THE GRAFTED FIBERS. Ichiro Sakurada and Toshio Okada (Japan Association for Radiation Research on Polymers). Doitai To Hoshasen, 4: 363-74(Dec. 1962). (In Japanese)

Grafting of styrene, methyl methacrylate, acrylonitrile, and 2-methyl-5-vinyl pyridine to poly (vinyl alcohol) fibers by γ irradiation was carried out, and the mechanical properties of the grafted fibers were measured. The fibers used in the experiments were dried, heat-treated, and formalized fibers. Regardless of the monomer used, the easiness of the grafting was in the following order: dried fiber > heat-treated fiber > formalized fiber. In some cases the grafted fibers were further subjected to heat treatment or formalization. When the fibers were grafted with styrene or methyl methacrylate, the fibers became more thermoplastic and improvement of the elastic recoveries and heat setting properties was observed. Fibers grafted with 2-methyl-5-vinyl pyridine showed good dyeability when the degree of grafting was higher than 5%. (auth)

11181 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO POLYVINYL ALCOHOL. XI. GRAFTING OF STYRENE TO DRY POLY (VINYL ALCOHOL) FILMS IN STYRENE-METHANOL SOLUTION AT HIGHER TEMPERATURES BY GAMMA IRRADIATION. Ichiro Sakurada and Toshio Okada (Japan Association for Radiation Research on Polymers). Doitai To Hoshasen, 4: 375-82(Dec. 1962). (In Japanese)

It is shown that the radioinduced grafting of styrene to dry poly (vinyl alcohol) films occurs in styrene-methanol solution without the presence of water at a higher temperature than 40°C. The favorable effect of other solvents is far less remarkable than that of methanol. The effect of methanol seems to be related to the swelling power, for the degree of swelling of PVA films also becomes appreciable first at 40°C. When the styrene to methanol ratio is varied, the rate of the grafting is highest at a higher methanol concentration. The optimum temperature for the grafting is 70°C at a dose rate of 1.1×10^4 R/hr and 55°C at a dose rate of 4.8×10^3 R/hr. (auth)

11182 THE DIFFUSION PENETRABILITY OF A POLYMER DURING ITS RADIATION DESTRUCTION IN VARIOUS PHYSICAL STATES. R. S. Maslovskaya, A. B. Taubman, and L. P. Yanova (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 1155-8 (Oct. 11, 1964). (In Russian)

The formation of radiolytic gases in irradiated polymethacrylate (PMM) and polybutylmethacrylate (PBM) decreases near the melting or solidification point of the substance. Because of the low diffusion rate in the glassy state, local supersaturation of radiolytic gas is obtained, and the rate of gas formation falls off. To test this hypothesis the diffusion coefficients D and penetrability coefficients P were determined on irradiated and unirradiated samples of PMM and PMB in various states of aggregation. The PMM samples

were given a dose of 1×10^{21} ev/g and the PBM samples a dose of 0.3×10^{21} ev/g. Relatively thick films (0.4 to 0.5 mm) of PMM and PMB were used in the studies. A plot of log D versus 1/T gives a straight line with a point of inflection at the melting temperature, where the values of D and P vary by two orders of magnitude. PBM shows greater diffusion than does PMM. The values of D for irradiated PMM are 6.3×10^{-9} cm^2/sec at 25°C, and 570×10^{-9} cm^2/sec at 110°C (irradiated at $t < T_m$, where T_m is the melting temperature). On irradiation of the PMM sample at $t > T_m$, the corresponding values of D are 170×10^{-9} cm^2/sec at 25°C, and 4460 cm^2/sec at 110°C. The penetrability increases in a similar manner on irradiation at $t > T_m$. These effects are due to the formation of gaseous radiolytic products causing the appearance of microdefects in the polymer structure. Analogous results were obtained with PBM. (TTT).

11183 THE MECHANISM OF THE RADIATION POLYMERIZATION OF ACRYLONITRILE AND METHYLMETHACRYLATE IN THE PRESENCE OF SOLID ADDITIVES. L. P. Mezhirova, A. P. Sheinker, and A. D. Abkin (Karpov Inst. of Physical Chemistry, USSR). Dokl. Akad. Nauk SSSR, 158: 1159-61(Oct. 11, 1964). (In Russian)

The rate of polymerization of acrylonitrile (AN) and of methylmethacrylate (MM) by gamma irradiation at low temperatures increases sharply in the presence of p-type, semiconducting oxides such as nickel oxide and magnesium oxide. In order to determine the mechanism of polymerization (radical or ionic), mixtures of AN and MM were subjected to ^{60}Co gamma irradiation at a dose rate of 45 R/sec. The rate of copolymerization of AN with MM at −50°C in the presence of magnesium oxide is about an order of magnitude higher than it is without magnesium oxide. The resulting copolymer is enriched in the acrylonitrile component. On the other hand, the copolymer obtained with MgO is enriched in the methylmethacrylate component. The data indicate that the reaction proceeds primarily by way of an anion mechanism in the presence of MgO. Anionic polymerization takes place not only at −50, but also at 0°C. The reaction yield increases on going from 0 to −50°C. (TTT)

11184 STUDIES ON α-HALOACRYLIC POLYMERS. X. QUENCHING EFFECT OF POLY (α-CHLOROACRYLATE) AND THOSE DEHALOGENATED POLYMER ON THE FLUORESCENCE OF LIQUID SCINTILLATOR OF SOLVENT. Seizo Okamura and Yoichi Yamada (Kyoto Univ.). Isotopes Radiation (Tokyo), 4: 331-42(Dec. 1962). (In Japanese)

The radioinduced fluorescence of liquid scintillators involving poly-(α-chloroacrylate) or its dehalogenated polymer was investigated. From the quenching effect, the possibility of obtaining double bonds in dehalogenated polymers was considered. Benzene or dioxane as solvents and p-terphenyl as fluorescent solutes were used. Poly (α-chloroacrylate) was dehalogenated with diethylamine in dioxane. It was discovered that poly-(α-chloroacrylate) has quenching ability, and these abilities were found to be the same for all ester groups with these carbon numbers. Consequently, it was recognized that the Cl atom in the polymer has quenching ability the same as in low molecular substances. The double bonds in the main chain of the polymer produced by dehalogenation with diethylamine have strong quenching effects. It was considered that the quenching ability of dehalogenated poly-(α-chloroacrylate) is increased by the conjugation of double bonds with carbonyl in side groups, and of these double bonds with other double bonds in the same polymer main chain. From the quenching effect of dehalogenated poly-(α-chloroacrylate), the analysis of double bonds in these polymers was considered. (auth)

11185 STUDIES ON α-HALOACRYLIC POLYMERS. XI. QUENCHING EFFECTS OF COPOLYMER AND MIXTURE OF POLY (ETHYL α-CHLOROACRYLATE). Seizo Okamura and Yoichi Yamada (Kyoto Univ.). Isotopes Radiation (Tokyo), 4: 343-52(Dec. 1962). (In Japanese)

Quenching effects of poly (methyl acrylate), poly (methyl methacrylate), and poly (ethyl α-chloroacrylate) were investigated with respect to the groups in α positions. The relation between their quenching effects and their molecular structures was considered. Moreover, in investigating the quenching effects of mixtures and copolymers of poly (α-chloroacrylate) and some vinyl polymers, it was found that experimental values agree well with theoretical values obtained from kinetical treatment. It was suggested that from these experimental values of quenching, the composition of a copolymer or polymer mixture can be determined. (auth)

11186 STUDIES ON α-HALOACRYLIC POLYMERS. XII. QUENCHING THE FLUORESCENCE OF LIQUID SCINTILLATOR OF SOLVENT BY ORGANIC HALOGEN. Seizo Okamura and Yoichi Yamada (Kyoto Univ.). Isotopes Radiation (Tokyo), 4: 353-62(Dec. 1962). (In Japanese)

The radioinduced fluorescence of liquid scintillators involving organic halogens was investigated. Benzene for solvent and p-terphenyl for fluorescence were used. Organic halogens were chlorides of methane, ethane, propane, and butane. The kinetics of the quenching effect of fluorescence were introduced considering the excitation of those chlorides by radiation in the presence of benzene, and the kinetical equations were compared with experiments. Several facts about the quenching effect of organic chloride were obtained. (auth)

11187 ON THE POSSIBLE MECHANISM OF THE INFLUENCE OF RADIOACTIVE IMPURITIES ON CHEMOSORPTION AND CATALYTIC PROPERTIES OF SEMICONDUCTORS. V. G. Baru and F. F. Vol'kenshtein (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR Ser. Khim., No. 11, 1935-42(Nov. 1964). (In Russian)

Theoretical analyses were made of the charge and ionization effects on the adsorption and catalytic properties of semiconductors. It was found that adsorption and catalytic variations in semiconductors are caused by variations in electron and vacancy concentrations on the plane of the specimen surface. It was also found that the charge mechanism predominates at low specific radioactivity while ionization predominates at high. (R.V.J.)

11188 MECHANISM OF RADIOLYTIC REDUCTION OF CERIC IONS IN AQUEOUS SULFURIC ACID SOLUTIONS AT HIGH DOSE RATES. A. K. Pikaev and P. Ya. Glazunov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR Ser. Khim., No. 11, 1944-51(Nov. 1964). (In Russian)

The yields of Ce^{3+} ions and mixtures of peroxydisulfuric and peroxymonosulfuric acids from radiolysis of cerium peroxysulfate solution with 10^{23} ev/ml sec doses were determined. Investigations of $G(Ce^{3+})$ and $G(H_2S_2O_8+H_2SO_5)$ dependence on H_2SO_4 and Ce^{3+} concentrations at the dose used showed that the yields tended to diminish with increasing concentration of Ce^{3+}. With increased H_2SO_4 the yield of persulfuric acids increased while Ce^{3+} decreased. At low doses the persulfuric acids were formed by direct irradiation of sulfuric acid. The mechanism of radiolytic Ce^{3+} and Ce^{4+} transformations and per acid formations at large absorbed doses was analyzed. (R.V.J.)

11189 RADIATION POLYMERIZATION OF TRIALLYLSILANES. L. E. Gusel'nikov, N. S. Nametkin, L. S. Polak, and T. I. Chernysheva (Topchiev Inst. of Petroleum Chemical Synthesis, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR Ser. Khim., No. 11, 2072(Nov. 1964). (In Russian)

Radioinduced cyclopolymerization of triallylsilanes was studied using methyl- and phenyltriallylsilane monomers γ irradiated with gamma doses of 1.5×10^6 r/hr at 30°C. (R.V.J.)

11190 STEAM AND HEAT SETTING OF NYLON 6 FIBER. VIII. VISCOELASTIC AND THERMAL BEHAVIOR OF HEAT-SET OR γ-IRRADIATED NYLON 6 FIBER. A. Koshimo (Nippon Rayon Co., Ltd., Kyoto). J. Appl. Polymer Sci., 9: 69-79(Jan. 1965).

Steam setting and dry heat setting was repeated alternately on nylon 6 fibers in which no further increase of crystallinity was expected, and the viscoelastic behavior of these fibers was investigated. The stress relaxation and thermal stress data indicated that steam setting

weakens or breaks intermolecular bonds in the noncrystalline regions, while dry heat setting reforms the bonds. For unset and steam-set nylon 6 fibers, which were γ-irradiated at doses of about 10^7 R, results of determinations of viscoelasticity, dye diffusion, and breaking in solvent showed that cross-linking predominates with irradiation in a vacuum and scission predominates with irradiation in air. (auth)

11191 RADIATION EFFECTS ON POLYSTYRENE IN SOLUTION. E. Pedemonte, C. Cuniberti, C. Rossi, and U. Bianchi (Università, Genoa). J. Appl. Polymer Sci., 9: 385-98(Jan. 1965).

Four polystyrene samples, with molecular weights ranging from 43,300 to 1,112,000, were irradiated in benzene solution by γ rays, at four different intensities. Data obtained through intrinsic viscosity and light-scattering measurements on irradiated polymers indicated that, at each intensity, there exists a molecular weight below which any polymer chain is not further degraded. An equilibrium between absorbed and dissipated energy by the macromolecule is supposed, and the equation, $M_{lim}I$ = constant arrived at in a previous study, was verified by the experimental results. (auth)

11192 THE EFFECT OF UNIFORM GAMMA RAY FOGGING ON THE DIAGNOSTIC USEFULNESS OF COMMERCIAL X-RAY FILM. G. G. Copestake and J. C. F. MacDonald (Univ. of Western Ontario, London). J. Can. Assoc. Radiologists, 15: 23-6(Mar. 1964).

In the aftermath of a nuclear attack a major problem confronting the radiologist would be the exposure of his stock of radiographic film by γ radiation from fallout material. It is impossible to predict the exposure to stored film in advance of such an attack, because of the uncertainty in fallout distribution and the effects of shielding in a particular location. Such fogging would reduce the diagnostic value of the finished radiograph. Since little is known about the levels of γ exposure dose to which commercial x-ray film may be exposed without serious impairment of its usefulness in radiology, an investigation was undertaken to examine this problem. The primary radiations from ^{60}Co and ^{137}Cs were chosen because of availability of sources, and because the average energy of early fallout is close to the 1.25-Mev energy of ^{60}Co radiation, while that of late fallout is closer to the 0.66-Mev energy of ^{137}Cs γ rays. The films, which were irradiated in the primary beam, were commercial Ilford Red Seal screen type x-ray films. Doses of 0.5, 1.0, 2.0, 4.0, 8.0, and 16 R were used. The radiographic contrast decreased with the level of γ-induced fogging of the films. This decrease was linear with the logarithm of the fogging exposure over a wide range for both ^{60}Co and ^{137}Cs radiation. While slight differences were apparent in the diagnostic value of the films exposed to ^{60}Co and ^{137}Cs sources, no clear-cut distinction could be made between the effects of the two types of radiation, owing to the difference in radiation conditions with the two sources. As expected, the likelihood of obtaining a diagnostically acceptable film decreased as the thickness of the part being studied increased. On the other hand, an image which might be of value for detecting grosser details, such as major fractures, could be obtained of the band and the skull up to fairly high levels of fogging exposure. Diagnostic details were lost at a much lower fogging dose in studies of infants' chests. It is concluded that, in the event of a film stock suffering irradiation under disaster conditions, samples could be withdrawn and processed. From the degree of fogging, a rough estimate of exposure could be made. Films which received fogging doses up to about two R could be labeled suitable for extremity radiography, and some salvage could be achieved, using standard radiographic exposures. (BBB)

11193 MERCURY-SENSITIZED PHOTOLYSIS OF PROPYLENE PRIMARY AND RADICAL REACTIONS. Carl A. Heller and Alvin S. Gordon (Naval Ordnance Test Station, China Lake, Calif.). J. Chem. Phys., 42: 1262-8(Feb. 15, 1965).

A description is given of the mercury-sensitized photolysis of propylene and mixtures of propylene with H_2, D_2, and propylene-d_6 at 26°C using 253.7 and 184.9-nm light. There are at least five primary steps: $C_3H_6^* \rightarrow H + C_3H_5$, $C_3H_6^* \rightarrow CH_3 + C_2H_3$, $C_3H_6^* \rightarrow$ cyclopropane, $C_3H_6^* \rightarrow CH_4 + C_2H_2$, and $C_3H_6^* \rightarrow H_2 + (C_3H_4)$. The ratios of the primary reaction rates depend on the wavelength of the light and the deuteration of the propylene. Addition of hydrogen atoms to the propylene double bond gave 5% n-propyl radicals. No evidence was found of vinyl–vinyl radical combination to form butadiene. The cross-combination ratio of isopropyl and allyl radicals was 6.5. (auth)

11194 STUDY OF COLLISION EFFECTS BETWEEN THE CONSTITUENTS OF A MIXTURE OF HELIUM AND NITROGEN GASES WHEN EXCITED BY A 10-kev ELECTRON BEAM. Daniel I. Sebacher (Langley Research Center, Hampton, Va.). J. Chem. Phys., 42: 1368-72 (Feb. 15, 1965).

Measurements were made of the effects of collisions between nitrogen and helium excited by a 10-kev electron beam. The interaction between the excited particles was found to give rise to an afterglow of the 3914-Å band of N_2^+ on the order of 10^{-7} sec, which was observable at concentrations of helium greater than 75%. A departure from a Boltzmann distribution of rotational energies of the N_2^+ band was also measured. (auth)

11195 THE PULSE RADIOLYSIS OF AQUEOUS TETRANITROMETHANE. I. RATE CONSTANTS AND THE EXTINCTION COEFFICIENT OF e_{aq}^-. II. OXYGENATED SOLUTIONS. Joseph Rabani, William A. Mulac, and Max S. Matheson (Argonne National Lab., Ill.). J. Phys. Chem., 69: 53-70(Jan. 1965).

Aqueous solutions of tetranitromethane (TNM), both deaerated and oxygenated, were investigated by the technique of pulsed radiolysis. This system enabled the direct determination of ϵ_e^{5780}, the extinction coefficient of the hydrated electron, at 5780 Å as 10,600 (±10%) $\underline{M}^{-1}$ cm^{-1}. ϵ_e^{5780} is essential for evaluating rate constants previously determined as k/ϵ_e^{5780}. Also from ϵ_e^{5780} $G_e = 2.6$ was calculated from values of $G_e \times \epsilon_e^{5780}$. A number of rate constants were determined, including $k(e_{aq}^- + TNM) = 4.6 \times 10^{10}$ $\underline{M}^{-1}$ sec^{-1}, $k(H + TNM) = 5.5 \times 10^8$ $\underline{M}^{-1}$ sec^{-1}, and $k(e_{aq}^- + NF^-) = 3.0 \times 10^{10}$ $\underline{M}^{-1}$ sec^{-1}, where NF^- is the nitroform ion. Rate constants were also measured for reaction of several organic radicals with TNM. In the presence of O_2, $k(O_2^- + TNM)$ was measured as 1.9×10^9 $\underline{M}^{-1}$ sec^{-1}. $k(HO_2 + TNM)$ is less than 10^{-5} as large. Measurement of the effective k as a function of pH gave pK = 4.45 ± 0.25 for the dissociation, $HO_2 \rightleftharpoons H^+ + O_2^-$. (auth)

11196 ON THE DEGRADATION AND ELECTRON SPIN RESONANCE SPECTRA OF IRRADIATED METHACRYLATE POLYMERS. J. F. Kircher, F. A. Sliemers, R. A. Markle, W. B. Gager, and R. I. Leininger (Battelle Memorial Inst., Columbus, Ohio). J. Phys. Chem., 69: 189-93 (Jan. 1965).

A study was made of the degradation of irradiated methacrylate polymers, the formation and trapping of free radicals, and their electron spin resonance (ESR) spectrum. Several different radicals were apparently formed and it seems necessary to assume that they are formed by different mechanisms. This is also suggested by a number of observations of main chain degradation and the ratio of chain scission to ester removal for several methacrylate polymers. It is probable that several mechanisms of degradation and radical formation are operative and the one predominates is dependent on the pendant ester structure. (auth)

11197 KISHI LAG TIMES FOR O_2 ADSORPTION ONTO IRRADIATED POLY(BISPHENOL-A CARBONATE) AND POLY(METHYL METHACRYLATE). R. E. Barker, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Polymer Sci., Pt. A, 2: 5213-20(Dec. 1964).

Re-examination of data which were originally taken to determine diffusion coefficients and their variation with applied stress in electron irradiated poly(bisphenol-A carbonate) and poly(methyl methacrylate) verified the existence of Kishi induction periods t_i for the initial stages of O_2 sorption by these polymers. The data conform to the relation $t_i = t_i^0 e^{E/RT} e^{-p/p_i}$. New gas sorption data for poly

(bisphenol-A carbonate) by Norton are utilized in conjunction with data and equations from a previous paper by the author to estimate initial concentrations of the free radicals associated with the visually sharp diffusion boundary. The value G[oxygen-bleached color-centers/h.e.v.] obtained for these radicals is compared with recent viscometric determinations by Golden and Hazell. (auth)

11198 DECOMPOSITION AND STABILIZATION OF POLYVINYL CHLORIDE. PART V. RADIOLYSIS AND ELECTRON SPIN RESONANCE (ESR). Ko Morikawa (Osaka Municipal Technical Research Inst.). Kagaku To Kogyo (Osaka), 38: 199-206(Apr. 1964). (In Japanese)

Results obtained on gas evolution, crosslinking, coloring, and electron spin resonance (ESR) of polyvinyl chloride (PVC) irradiated with high energy radiation are summarized, and the mechanisms of radiolysis of PVC are discussed. It was concluded from the ESR studies that four kinds of free radicals are present in the PVC irradiated at −196°C in vacuum. These free radicals are identified, by the structure and decaying behavior of the ESR spectra, as $\sim CH_2-\dot{C}H-CH_2\sim$, $\sim CHCl-(CH{=}CH)_n-\dot{C}H-CHCl\sim$, $\sim CHCl-\dot{C}H-CHCl\sim$, and $\sim CH_2-\dot{C}Cl-CH_2\sim$; the G values are in good agreement with those from the gas evolution or crosslinking data. The ESR spectra of the PVC irradiated in air have two unsymmetrical peaks that correspond to $RO_2\cdot$ peroxide radicals. In the primary act of the radiolysis of PVC, the scission of Cl atoms is not so predominant as in the thermal degradation and the $\sim CHCl-\dot{C}H-CHCl\sim$ radicals are the starting points of the zipper reaction, which results in the formation of the conjugated double bonds. (NSA of Japan)

11199 RING-OPENING COPOLYMERIZATION OF α-TRIOXYMETHYLENE AND HEXAMETHYLCYCLOSILOXANE BY SOLID STATE γ-RAY IRRADIATION. Mizuho Sugihara and Isao Hashida (Osaka Municipal Technical Research Inst.). Kagaku To Kogyo (Osaka), 38: No. 5, 28-30 (May 1964). (In Japanese)

Ring-opening copolymerization of α-trioxymethylene and hexamethylcyclosiloxane in the solid state by γ irradiation was attempted. Mole ratio of the two compounds, total dose, and temperature were changed. Polymethylsiloxane was extracted from the polymerization products with benzene in a Soxlet extraction apparatus. It was ascertained that copolymerization had occurred, but Si content of the copolymer was rather small; therefore it was supposed that α-trioxymethylene was more easily polymerized than hexamethylcyclosiloxane by γ irradiation. (auth)

11200 RADIATION VULCANIZATION OF AUTOMOBILE TIRES AND PROTECTIVE TREADS IN THE IRT REACTOR. M. A. Kaplunov. Kauchuk i Rezina, No. 4, 10-13(Apr. 1963). (In Russian)

Test samples of automobile tires and protective treads were vulcanized by γ radiation in the IRT reactor when the reactor was shut off and by mixed neutron and γ radiation when it was in operation. Natural and butadiene-styrene rubbers, to which were added 50% by weight channel carbon black and 10% hexachloroethane sensitizer, were used. The cord consisted of capron polyamide fiber. The steel mold of the tire and the protective treads were enclosed in an Al casing, which was screened with 1-mm Cd sheet to protect them from neutron radiation. The protective treads were also insulated with boron carbide. Irradiation in the nonoperating reactor did not produce the desired effect because of the low γ flux; therefore, further tests were conducted only when the reactor was in operation. The quanta of γ radiation received by the tires averaged 25 Mrad for a period of 45 hr. The samples obtained were subjected to standard static and dynamic tests, which showed that radioinduced vulcanization was superior to conventional vulcanization, and that tires were produced with a 30% lower rolling resistance and a 15 to 20°C lower temperature within the tire during the rolling test. Preliminary road tests showed 30 to 40% superior wear for the radiation-vulcanized tires. (OID)

11201 THE EFFECT OF THE CHEMICAL CHARACTER OF THE FILLER SURFACE AND IONIZING RADIATION ON THE PROPERTIES OF RUBBER. A. A. Chuiko. Kauchuk i Rezina, No. 6, 31-4(June 1963). (In Russian)

The effect of the chemical character of the filler surface on the physicomechanical properties of rubbers was studied. Butadiene–styrene (SKS-30), nitrile (SKN-40), and sodium butadiene (SKB) rubbers, loaded with unmodified silica and with silica in which the surface hydroxyls were substituted with allyloxy or vinyl radicals, were used. The use of modified silica in standard rubber mixes (containing 100 parts of rubber and 50 to 60 parts of filler) improved the physicomechanical properties of the vulcanizates. ^{60}Co γ radiation at a dose rate of 77 R/sec on unloaded SKS-30 rubber and on SKS-30 loaded (ratio 1/1) with unmodified and with modified silica containing 2.5% vinyl, methyl, or ethyl radicals did not affect the tensile strength or the modulus of elongation of unloaded rubber but improved these properties in loaded rubbers, particularly those with vinyl silica. The maximum radiation effect was attained after 48 hr. (OID)

11202 RADIATION GRAFTING OF VINYL MONOMERS OF POLYOLEFIN FIBERS. U. Jung-jui. Khim. Volokna, No. 5, 12-15(1963). (In Russian)

A method for grafting polymerization was developed for different vinyl monomers on polypropylene fibers which had been subjected to preliminary ^{60}Co γ-radiation in the presence of air. It was found that by increasing the amount of radiation on polypropylene and polyethylene fibers, the peroxide group content increased but the strength and elongation decreased, respectively. In the presence of 3 to 4 times $FeSO_4\cdot 7H_2O$ with respect to the peroxide group, the process of graft polymerization of acrylic acid and 2-methyl-5-vinyl pyridine to the previously irradiated polypropylene fiber which contained an antioxidant, proceeded without the formation of a homopolymer. However, in the graft polymerization of acrylonitrile, the formation of a small amount of the homopolymer was observed. Graft polymers can be obtained from polyethylene fibers, which contain an antioxidant, without the formation of a homopolymer, if the fibers are irradiated before the processing begins. (OID)

11203 DYNAMIC VISCOELASTIC PROPERTIES OF GRAFT COPOLYMERS. I. POLYVINYL FLUORIDE-STYRENE GRAFT COPOLYMER. T. Honjō and S. Ogawa. Kogyo Gijutsuin Sen'i Kogyo Shikenjo Kenkyu Hokoku, No. 65, 1-6(Oct. 1963). (In Japanese)

Polyvinyl fluoride (PVF) grafted with styrene was prepared directly by ^{60}Co γ-irradiation, and its dynamic viscoelastic properties measured at 20 cps and 5°C/min increments between 20 and 180°C were compared with those of the pure PVF film. Results indicated that PVF had 2 dispersions (α and β) between room temperature and the melting point (200°C). From measurements on the drawn sample, it was concluded that the α-dispersion (upper) at 145°C depended on the crystalline region, whereas the β-dispersion (lower) at 73°C was the so-called main dispersion of the amorphous region. The PVF crystallite was slightly damaged by irradiation at 5.35×10^6 R. The graft-copolymer dispersion showed an intermediate property between PVF and polystyrene. With increasing graft ratio, the α-dispersion became stronger, narrower, and shifted to a lower temperature (115°C). Above the graft ratio of 0.3, the β-dispersion became weaker and disappeared. This suggested that the styrene monomer was grafted in the amorphous region of PVF. (OID)

11204 TEMPERATURE DEPENDENCE OF THE X-RAY INDUCED LUMINESCENT SPECTRA OF THALLIUM-ACTIVATED ALKALI HALIDE CRYSTALS. E. D. Aluker and I. P. Mezina (Inst. of Physics, Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad., Vestis, Fiz. Tek. Zinatnu Ser., No. 4, 17-22(1964). (In Russian)

The dependence of the x-ray induced luminescent spectra on temperature was measured for KCl–Tl, KBr–Tl, KI–Tl, NaI–Tl, and CsI–Tl crystals. The coincidence of the thermoluminescent spectra of all crystals with the x-ray-induced luminescent spectra is shown. The emission of the usual thallium centers was observed in the alkali iodides with a large thallium concentration in the temperature range from 100 to 500°K. With change of tem-

perature in the KCl–Tl and KBr–Tl crystals the distribution of intensity between the bands corresponding to the emission of different thallium centers and pure crystals took place. (auth)

11205 OBTENTION OF SILICON OF HIGH RESISTIVITY. J. Messier (C.E.N., Saclay, France). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 115-18(1964). (In French)

The preparation of high resistivity silicon compensated by using the transmutation of Si into P under the bombardment of a thermal neutron flux was investigated. The utilization of silicon purified by the floating zone technique and in which there is a homogeneous distribution of boron atoms was seen to be necessary. The existence of residual faults at the end of the annealing adversely affected the realization of perfect compensation. (J.S.R.)

11206 GAMMA-RAY INDUCED GRAFT COPOLYMERIZATION. IX. THE COMPOSITION OF CELLULOSE ACETATE–STYRENE GRAFTED FIBER. Kiyoshi Hayakawa and Kaoru Kawase (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 13: No. 3, 118-23(Mar. 1964). (In Japanese)

The compositions of two kinds of cellulose acetate fibers on both of which styrene was grafted, one prepared by a γ-ray immersion technique at 25°C (IG) and the other by a pre-irradiation technique at 65°C (PG), were investigated by the solvent extraction method. Components such as unreacted cellulose acetate, occluded polystyrene, and graft copolymer were separated from the grafted fibers. Polystyrene occluded in IG (93.0% apparent grafting) amounted to 28%, but only 2% of the fibers were found to be occluded polystyrene in PG (67.2% apparent grafting). In both cases the molecular weights of the occluded polystyrene were slightly higher than those produced in the liquid phase. The amounts of unreacted cellulose acetate extracted from IG and PG were 83 and 93% respectively. Their molecular weights did not seem to change during irradiation. The molecular weights of branch polystyrenes, obtained by hydrolysis of graft copolymers, were 4.0×10^5 in IG, and 1.7×10^6 in PG, respectively. Each was higher than other component polystyrenes. The compositions and solution viscosities of graft copolymers are also discussed. (auth)

11207 PULSED RADIOLYSIS OF CYCLOHEXANE SOLUTIONS: EVIDENCE FOR REACTIONS OF ELECTRONS. G. Scholes (Univ. of Newcastle-upon-Tyne, Eng.), M. Simic, G. E. Adams, J. W. Boag, and B. D. Michael. Nature, 204: 1187-8(Dec. 19, 1964).

Results of pulsed radiolysis experiments using cyclohexane are presented, which corroborate earlier results suggesting that electron attachment can occur in irradiated liquid alkanes when suitable acceptors are present. It is concluded that reactions of electrons should be taken into account in any interpretation of radioinduced decomposition of hydrocarbon systems. (J.R.D.)

11208 ANNEALING BEHAVIOUR OF RECOIL COBALT-57 ATOMS IN HEXAMMINE NICKEL CHLORIDE. Kenji Yoshihara (Japan Atomic Energy Research Inst., Tokyo). Nature, 204: 1296(Dec. 26, 1964).

Studies were made on the behavior of recoil ^{57}Co atoms in hexammine nickel chloride on thermal annealing. A remarkable difference was found between annealing reactions of ^{57}Co atoms produced by the $^{58}Ni(\gamma,p)^{57}Co$ reaction and those of ^{57}Co produced by the decay processes of ^{57}Ni. In the case of the (γ,p) reaction, Co^{2+} (or its precursor) changes into $Co(NH_3)_5Cl^{2+}$ and $Co(NH_3)_6^{3+}$ on thermal annealing at 87°C. Increase of the $Co(NH_3)_5Cl^{2+}$ fraction is the main event in this case. On the decay processes, however, the main event on thermal annealing is increase of $Co(NH_3)_6^{3+}$, which corresponds to the decrease of Co^{2+} (or its precursor). For samples standing at room temperature, distribution of recoil products shows similar tendency to the annealed one. It was concluded that remarkable increase of $Co(NH_3)_5Cl^{2+}$ occurs by recombination of fragments. (P.C.H.)

11209 PHOTOCHEMISTRY AND RADIATION CHEMISTRY OF FLUOROBENZENE IN AQUEOUS AND OTHER SOLUTIONS. Israel Loeff, Louis M. Revetti, and Gabriel Stein (Hebrew Univ., Jerusalem). Nature, 204: 1300-1 (Dec. 16, 1964).

The photochemistry and radiation chemistry of fluorobenzene in aqueous and other solutions was compared. It was found that when aqueous solutions was compared. It was found that when aqueous solutions of fluorobenzene were irradiated in the presence of oxygen, with ionizing radiations from a 200 kvp x-ray set, that F^- was formed in the solution with a G-value that was somewhat influenced by the pH varying from about 3.35 at pH 1.2 to about 1.6 at pH 8.4. This relatively high G-value of fluoride formation was accompanied by the formation of hydrogen peroxide showing a change with pH from 2.1 at pH 1.2–1.5 at pH 8.4. When irradiations were carried out in the absence of oxygen, the G-value of fluoride formation was 4.55 at pH = 3.1 while that of hydrogen peroxide formation decreased to approximately 0.6. The results are entirely consistent with efficient displacement of fluoride from the aromatic ring both by OH radicals and by solvated electrons and H atoms. By comparison on illuminating aqueous solutions of fluorobenzene in the presence or in the absence of oxygen with uv light of 2537 A, it was found that the quantum yield of fluoride formation had the relatively low value of approximately 0.015, changing little with pH. (P.C.H.)

11210 PRODUCTION OF HYDROGEN IN THE RADIOLYSIS OF METHANOL VAPOR. G. M. Meaburn, F. W. Mellows, and A. Reiffsteck (Centre d'Etudes Nucleaires, Saclay, France). Nature, 204: 1301-2(Dec. 26, 1964).

Studies were made on the production of hydrogen in radiolysis of methanol vapor using nitrous oxide, methyl bromide, and propylene as potentially efficient scavengers. Irradiations were carried out with 260-kv electrons produced in single pulses of 0.2 μsec duration. The product gases were removed from the methanol after irradiation and the yields were determined by gas-solid chromatography. The yields obtained for pure methanol were: $G(H_2) = 10 \pm 2$; $G(CH_4) = 0.5 \pm 0.1$; and $G(CO) = 1.0 \pm 0.2$. The addition of up to 1% v/v nitrous oxide and up to 3% methyl bromide was found to have no effect on $G(H_2)$. The addition of propylene reduced the hydrogen yield. (P.C.H.)

11211 STUDIES ON THE INDIRECT ACTION OF RADIATIONS. PART 17. EFFECT OF X IRRADIATION ON AN AQUEOUS SOLUTION OF ANILINE. Hiroo Kumagai (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 21: 971-80(Jan. 1, 1962). (In Japanese)

Observations are reported on the radioinduced decomposition of aniline, with qualitative and quantitative measurements of the products. Irradiations were carried out with x rays of 90-kvp intensity at 1140 R/min; the doses were from 10^3 to 10^6 R. The concentrations of the remaining aniline and absorption spectra of the products were measured by means of a Hilger spectrophotometer. In the range from 0.5×10^{-5} mole to 10^{-3} mole of aniline concentrations, both the dilution effect and the oxygen effect were recognized. The temperature of solution during irradiation had little influence on the radiation effects; however, frozen material did not show radiation effects. At higher than 10^{-4} mole concentrations of aniline the ionic yield was consistently about 0.27. In the concentration range lower than 10^{-4} mole, however, the ionic yield diminished corresponding to the reduction in concentration. In oxygen-free solution the ionic yield was about half that of oxygenated solution, and the limit of concentration in which the dilution effect was recognized was about 5×10^{-5} mole, which was lower than in oxygenated solution. The irradiation of aqueous solutions of aniline led to decomposition of aniline with the production of phenol, diphenylamine, nitrosobenzene, ammonia, nitrobenzene, phenylhydroxylamine, and hydrazobenzene. (BBB)

11212 THE GAMMA-RAY IRRADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE ON AMYLOSE IN DIMETHYLSULFOXIDE SOLUTION. Akira Mishina and Ziro Nikuni (Osaka Univ.). Nippon Nogei Kagaku Kaishi, 38: 372-5(1964). (In Japanese)

With the aid of γ radiation, an attempt was made to synthesize a graft polymer of water-soluble amylose (amylodex-

trin) as the main chain and water-repellant styrene as the branching monomer to be grafted to the amylose in dimethylsulfoxide as the medium. About 0.5 g of purified and distilled amylose ([η] = 2.03, k' = 0.56, λ_{max} = 635 mμ, $E_{680m\mu}$ = 1.24) was dissolved in 5 ml of dehydrated and distilled dimethylsulfoxide (b.p. 189.0° to 189.5°) at 40° to 50°, and then 2.4 ml of dehydrated and distilled styrene ($b.p._{49mm}$ 62.0 to 62.5) was added. The mixture was subjected to γ irradiation (^{60}Co) at doses ranging from 4 to 800 × 10^5 r, under normal or reduced atmospheric pressure and at the room temperature. Five volumes of methanol were added to the irradiated specimen, and the precipitate was extracted thrice (8 hr each) with benzene. Methanol was again added to the benzene extract to precipitate the homopolymer of styrene (negative on iodine color test). The benzene extract residue was dissolved in 50 ml of dimethylsulfoxide and this was poured into 100 ml of water at 50° to 60°, eliminating the unreacted amylose, and obtaining the graft polymer (positive on iodine color test). Dimethylsulfoxide was found to be the most suitable solvent for both amylose and styrene. The yield of total, mono, and graft polymers was greater than that hitherto reported for styrene polymerization. The proportion of polystyrene in the graft polymer was 50 to 60%, varying little with the different experimental conditions. The viscosity of the grafted polystyrene was greater than that reported for acetylamylose-styrene polymerization. The high-dosage irradiation resulted in benzene-insoluble polystyrene after hydrolysis, probably the result of cross-linking. The addition of a small amount of water to the system appeared to accelerate the polymerization, but beyond a certain amount it hindered the process. Compared to benzene as a medium or to the condition where no solvent was used, dimethylsulfoxide showed a tendency to accelerate the polymerization. (BBB)

11213 ANALYTICAL WAVE FUNCTIONS AND PHOTOIONIZATION CROSS SECTIONS OF NEGATIVE IONS HAVING AN OUTER 2p ELECTRON SHELL. Yu. V. Moskvin. Opt. Spectry. (USSR) (English Transl.), 17: 270-2(Oct. 1964). Translated from Optika i Spektroskopiya, 17: 499-503(Oct. 1964).

Analytical expressions were obtained for the radial atomic wavefunctions of C^-, N^-, O^-; photoionization cross sections of the negative ions C^-, N^-, O^-, and F^- were calculated with the aid of analytical expressions for the radial wave functions. The conformity of the calculation with experiment is better indicated by the amplitude for the ions C^- and O^-. (auth)

11214 ON THE EXISTENCE OF TWO TYPES OF F CENTERS IN ADDITIVELY AND SUBTRACTIVELY COLORED ALKALI-HALIDE CRYSTALS. I. I. Ezhik. Opt. Spectry. (USSR) (English Transl.), 17: 307-9(Oct. 1964). Translated from Optika i Spektroskopiya, 17: 571-5(Oct. 1964).

The effect of ionic surroundings (M and R centers) on the absorption of infrared (IR) light by F centers at 77°K in KCl and NaCl crystals colored by x rays and by means of additives was investigated. It is shown that the interaction of M and R color centers with F centers leads to an increase in the decay time of infrared fluorescence of the F centers. Curves showing the decay of IR phosphorescence of the F centers and absorption spectra are presented. The presence of IR emission in the spontaneous phosphorescence spectra of F centers for crystals exposed to x rays indicates that optical de-excitation occurs in F centers during the phosphorescence. A mechanism is proposed to explain the de-excitation of F centers during the spontaneous phosphorescence of crystals subjected to x rays. (auth)

11215 RADIATION EFFECTS ON BIOLOGICAL MOLECULES. I. MAGNETIC RESONANCE STUDY. Tomio Matsuura and Toshiko Sugimura (Tokai Univ., Japan). Proc. Fac. Eng. Tokai Univ., No. 1, 27-35(Feb. 1964). (In Japanese)

From electron spin resonance spectra of some irradiated amino acids, peptides, purines, pyrimidines, nucleosides, nucleotides, DNA, and RNA, G values were obtained at the dry ice temperature, which nearly equals room temperature (20°C). By irradiation of the materials in aqueous solutions, G values were about half or less the values of materials that were irradiated in vacuum and then dissolved in water. Small differences were found in G values of purines, pyrimidines, etc., from amino acids and peptides by change of temperature and water content. (NSA of Japan)

11216 RADIATION EFFECTS ON BIOLOGICAL MOLECULES. II. MAGNETIC RESONANCE STUDY. Tomio Matsuura and Toshiko Sugimura (Tokai Univ., Japan). Proc. Fac. Eng. Tokai Univ., No. 2, 29-33(Mar. 1964). (In Japanese)

The nuclear magnetic resonance spectra of trifluoroacetic acid and D_2O solutions of amino acids, peptides, purine, pyrimidines, and nucleosides, which are irradiated by γ rays and electron beams of 1 Mev, are reported. Differences in chemical shifts between irradiation in solutions and in solids are discussed. (NSA of Japan)

11217 EFFECTS OF RADIATION ON POLYMERIC SUBSTANCES. POLYETHYLENE, POLYPROPYLENE AND POLYOXYMETHYLENE. Kazuo Manaka and Tamotsu Tomioka (Tokyo Shibaura Electric Co., Ltd.). Purasuchikku Zairyo, 5: No. 3, 38-45(Mar. 1964). (In Japanese)

Commercially available high- and low-density polyethylenes, polypropylene, and polyoxymethylene were irradiated and some of the properties of the irradiated polymers were investigated. Irradiations were carried out both in air and vacuum with gamma rays and high-energy electron beams. The dose rate for gamma rays was 3 × 10^5 R/hr, and the intensity of the 2 Mev electron beams was 250μA. The total doses were between 10^5 and 10^8 R. Flow properties of the irradiated polymers at elevated temperatures were investigated with a flow tester. The temperature-fluidity curves were found to be closely related with the degree of cross-linking or degradation of the polymers. The differences in the irradiation effect between air and vacuum and between gamma rays and electron beams were observed by the diffusion of oxygen during irradiation. Nuclear magnetic resonance absorption and, infrared absorption spectra and the results of chemical analyses are also given. (NSA of Japan)

11218 THE EFFECT OF METAL IONS ON THE RADIATION SENSITIVITY OF CATALASE. W. Lohmann, A. J. Moss, Jr., and W. H. Perkins (Univ. of Arkansas, Little Rock and Veterans Administration Support Center, Little Rock, Ark.). Radiation Res., 24: 9-14(Jan. 1965).

The influence of metal ions (Cu^{2+}, Mn^{2+}, Fe^{3+}) on the radiosensitivity of catalase was investigated spectrophotometrically. The radiation dose varied between 0 and 2.7 × 10^6 R. The protective effect was explained by a radical scavenging mechanism in which a reaction of metal ions with hydrated electrons (e^-_{aq}) seemed to be the primary process. Radiobiological implications are discussed. (auth)

11219 THE RADIOLYSIS OF PANCREATIC RIBONUCLEASE: KINETIC AND OPTICAL PROPERTIES. T. W. Smith and S. J. Adelstein (Harvard Medical School, Boston). Radiation Res., 24: 119-32(Jan. 1965).

Results of kinetic and optical studies of RNase irradiated in aqueous solution are presented. A comparison of radiolytic activity loss with respect to the two substrates ribonucleic acid and cytidine-2',3'-cyclic phosphate revealed no differential effect, the two enzymatic activities decreasing at a similar rate with increasing radiation dose. Progressive doses of x irradiation producing up to 58% loss in activity decreased the maximum velocity of cytidine-2',3'-cyclic phosphate hydrolysis without altering the Michaelis constant for the reaction. An atypical, irreversible melting and annealing curve for RNase was observed after irradiation. The difference spectrum of irradiated RNase was found to exhibit characteristic minima at 233.5, 280, and 287 mμ superimposed on a generalized increase in absorbancy from 400 mμ to below 240 mμ. The difference spectrum of irradiated RNase after hydrolysis was found to resemble closely that of an irradiated solution of pure tyrosine. Fluorimetric assay of tyrosine content before and after irradiation of RNase showed a linear decrease with increasing radiation dose which extrapolates to a loss of three tyrosine residues at 100% inactivation. The im-

plications of these findings are discussed, and a model consistent with the observed data is presented. (auth)

11220 EFFECTS OF NEUTRON IRRADIATION ON BROMOBENZENE AND SOME OF ITS DERIVATIVES. R. P. Poncha, C. L. Rao, and H. D. Sharma (Atomic Energy Establishment, Trombay, India). Radiochim. Acta, 3: 129-33 (Nov. 1964).

The retention value R, defined as the percentage of activity retained in the organic combination after irradiation of an organic halide was determined for bromobenzene; o, m, and p bromonitro benzene, o, m, and p bromoaniline and its sulfate. The values of R for bromobenzene show wide variation depending on the irradiation container, etc., apart from pretreatment for purification. The isomers of derivatives of bromobenzene show that there are no marked differences in the values of R but minor differences were observed which may be due to orienting effect of the substituents in the benzene nucleus. The effect of dilution on R of bromobenzene using benzene and hexane as solvents were studied and it is shown that the retention value goes down in benzene but in hexane it remains constant. The scavenging effects by addition of Br_2 and allyl bromide on bromobenzene showed that R goes down to ~ 30% in the former and ~ 87% in the latter case. (auth)

11221 OXYGEN-EFFECT IN ANNEALING OF RECOIL DAMAGE IN COBALT CHELATES-TRIS-ACETYL-ACETONE Co(III) AND BIS-SALICYLALDEHYDE TRIETHYLENETETRAMINE Co(III) CHLORIDE. Amar Nath, K. Annaji Rao, and V. G. Thomas (Atomic Energy Establishment, Trombay, India). Radiochim. Acta, 3: 134-6(Nov. 1964).

A marked O_2 effect is observed for several Co complexes in thermal annealing. Kinetic data are reported for recoil damage, after $^{59}Co(\gamma,n)^{58}Co$ and $^{59}Co(n,\gamma)^{60}Co$- reactions in trisacetylacetone Co(III) and bis-salicylaldehyde triethylenetetramine Co(III) chloride respectively. When the thermal treatment is carried out in N_2 or vacuum (viz., in absence of O_2), the magnitude of saturation anneal is considerably higher. Aliquots annealed to saturation in presence of air can be made to undergo further annealing, if the thermal treatment is continued at the same temperature but in the absence of air (in vacuum or N_2). It is suggested that during an isothermal annealing run electrons are released from variable depth traps, and interact, with the metastable species (damage centers) formed by virtue of interaction of recoil Co atom with a chelate molecule. The adsorbed O_2 on the surface acts as deep electron trap and suppresses annealing. Once it is displaced by N_2 (or vacuum), annealing proceeds further. The adsorbed O_2 is not found to affect the percentage contribution from individual rate processes (corresponding to different trapping centers) to an equal extent. This shows that the spatial distribution of different trapping centers in the bulk is not homogeneous. (auth)

11222 THE THERMAL ANNEALING OF NEUTRON-IRRADIATED CUPFERRATE. A. Rusi and S. Ionesco (Inst. of Atomic Physics, Bucharest). Radiochim. Acta, 3: 137-41 (Nov. 1964). (In French)

The thermal annealing of neutron irradiated $Fe(C_6H_5NO\text{-}NO)_3$ was studied. Its kinetics are characterized by two pseudoplateaus, of constant annealing rate, one for the isotherms at 60 to 100°C and the other for those at 105 to 110°C. These pseudoplateaus are discussed by several current theories. The semilogarithmic representation of the defects to be thermally annealed ($R_\infty - R_t$) gives a picture for the substitution of temperature by time, to achieve the same percentage of annealing. Drawing p_0 as a function of activation energy E_0 (theory of Vand and Primak), curves the maxima of which rise with temperature lowering are obtained for the various isotherms. The range of activation energies increases with temperature. The maxima corresponding to the first plateau coincide (0.995 ev). The areas under these maxima are roughly equal (70 to 100°C). The curves for the second pseudoplateau have no maxima, they are displaced by 0.05 ev towards higher activation energy. The existence of two pseudoplateaus might be explained by annealing in two different directions in the needle-shaped crystals. (auth)

11223 CHEMISTRY OF NUCLEAR PROCESSES. VI. THE MECHANISM OF MOLECULE-FORMATION BY NUCLEAR FISSION AND SUBSEQUENT PROCESSES IN SOLID MIXTURES. F. Baumgaertner and A. Schoen (Technische Hochschule, Munich). Radiochim. Acta, 3: 141-5(Nov. 1964).

Experiments at temperatures from 4 to 500°K show that, at least in the case of $^{103-105}Ru(C_5H_5)_2$-formation from U fission products, and a suitable target compound in the solid phase, i.e. $Fe(C_5H_5)_2 + U(n,f) \rightarrow {}^{103-105}Ru(C_5H_5)_2$ neither impact substitution by primary fission recoil nor unstable intermediate products nor normal chemical reactions nor thermal radical reaction nor radiation induced reactions play any part. The only origin of molecule formation is the β-decay of the fission product atoms and the role of primary fission recoil is only to transport the atoms inside the admixed target-compound. Furthermore it is shown by using target-compounds with different central atoms for substitution, i.e. $Fe(C_5H_5)_2$, $Ru(C_5H_5)_2$, $Os(C_5H_5)_2$, that the molecule formation process is not a high energy recoil process but occurs in an energy range where chemical bond-strengths of the target material are significant. (auth)

11224 CHEMICAL FORM OF NITROGEN-16 PRODUCED BY THE $^{16}O(n,p)$ ^{16}N REACTION IN WATER. J. J. Schleiffer and J.-P. Adloff (Centre de Recherches Nucléaires, Strasbourg). Radiochim. Acta, 3: 145-51(Nov. 1964). (In French)

The chemical forms of ^{16}N produced by $^{16}O(n,p)$ reaction on activation of water with 14 Mev neutrons were determined. Half-life of ^{16}N is only 7.35 s and fast analytical procedures were developed. 10% of the activity appears as a volatile fraction which is mainly NO. The water soluble activity is distributed as follows: NH_4^+ 30%, NH_2OH 16%, NO_3^- 25%, NO_2^- 10%. Mechanism schemes are proposed. (auth)

11225 OZONE: DECOMPOSITION BY IONIZING RADIATION. P. Harteck, S. Dondes, and B. Thompson (Rensselaer Polytechnic Inst., Troy, N. Y.). Science, 147: 393-4 (Jan. 22 , 1965).

The decomposition of ozone by ionizing radiation is explained by a negative ion-chain mechanism. That this mechanism may be pertinent is indicated by the results obtained from the irradiation of liquid oxygen and the irradiation of oxygen containing nitrogen. (auth)

11226 IRRADIATION OF γ-RAYS UPON CINNAMIC ACID AND OTHER COMPOUNDS IN VACUUM OR IN NITROGEN. Seiichi Ishikawa and Kazuko Kawada (Jissen Women's Univ., Japan). Shinku Kagaku, 12: No. 2, 53-6(Apr. 1964). (In Japanese)

It has been well known that cinnamic acid was changed to various isomers of cyclobutane by irradiation by ultraviolet or visible rays and that ketol was a dimer of vitamin A. It was found that cinnamic acid and γ-ethyl phenyl acetate were not polymerized or decomposed by irradiation by γ rays in vacuum or in nitrogen. (auth)

11227 SOME PECULIARITIES IN THE BLEACHING OF NEUTRON-IRRADIATED ALKALI HALIDE CRYSTALS BY ISOTHERMAL ANNEALING. B. V. Budylin and Yu. F. Kozlov. Soviet Phys.-Solid State (English Transl.), 6: 1237-43 (Dec. 1964). Translated from Fiz. Tverd. Tela, 6: 1573-8 (June 1964).

The isothermal annealing of single crystals of the iodides and bromides of alkali metals, subjected to an integrated neutron flux of over 10^{18} n/cm^2, leads to the anomalous destruction of color centers in the zone adjoining the boundaries of the crystal. The formation and growth of macroscopic pores is observed throughout the whole volume of the specimens undergoing annealing. Pore development is accompanied by an increase of the intensity with which visible light is scattered, and by an acceleration of anomalous localized bleaching. (auth)

11228 NEAR-INFRARED ABSORPTION BANDS IN IRRADIATED SILICON CRYSTALS. E. N. Lotkova (Lededev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 6: 1500-1(Dec. 1964). Translated from Fiz. Tverd. Tela, 6: 1905-7(June 1964).

A study was made of the intense and narrow near-infrared absorption band at 1.8μ in Si monocrystals irradiated by 2-Mev neutrons and 1.2-Mev electrons. The variation of the absorption intensity with radiation dose was measured, for fluxes of 10^{17} to 10^{18} neutrons/cm^2 and 10^{18} electrons/cm^2. (M.J.T.)

11229 THE INFLUENCE OF EXCITATION ENERGY TRANSMISSION ON THE YIELD FROM HOT ATOM REACTIONS. E. S. Filatov and An. N. Nesmeyanov. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 13-18(July-Aug. 1964). (In Russian)

Some of the aspects of the effect of excitation energy transmission on hot atom reaction yields were developed mathematically. (16 references) (IIC-M.G.)

11230 STUDIES ON X-AGENT. XXXVII. INFLUENCE OF COLOURS, ESPECIALLY RED COLOUR, ON THE SEDIMENTATION OF NEUTRAL RED. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 91-102(June 1964).

The precipitation or the crystallization of neutral red was found to be affected by red-colored water in which a solution of the pigment contained in a test tube was immersed. Such an effect was seen in red color whether it was produced by neutral red or by phenolphathalein. Thus, the effect disappeared when the red color was lost by the change of pH. The effect was altered with the change in intensity of red color. The effect of red color varied remarkably with the change of time and place, and the effect was found sometimes to be reverse. These facts show that the red light interfered with the action of the X agent. The effect was demonstrable even in a complete darkness in a black-paper box, showing that ordinary light has no concern with this effect. When covered with 5-cm lead shield, however, the effect was not demonstrable. The X-agent concerned in this effect, therefore, is considered to be not so hard as being able to penetrate the lead shield, although it can pass through thick, black paper. Evidence was presented that blue and yellow colors have similar effect, though the effect is very slight as compared with that of red color. Non-colored inorganic substances dissolved in water had no such effect. (auth)

11231 STUDIES ON X-AGENT. XXXVIII. EFFECT OF ALUMINIUM-FOIL OF VARIOUS THICKNESS ON THE SEDIMENTATION OF NEUTRAL RED. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 141-8(Aug. 1964).

The degree of sedimentation of neutral red is affected when the test tube containing the pigment solution is covered with aluminium foil. The effect of aluminium foil varies with the thickness of the foil. This effect can be demonstrated only in a place close by a window; if the place is separated from the window, it generally is not observed. The degree of pigment sedimentation differs with the method of holding the test tube containing the pigment solution. Hence, it is shown that the X-agent concerned in the pigment sedimentation is very soft or very low in energy. (auth)

11232 STUDIES ON X-AGENT. XXXIX. PRESENCE OF X-AGENT IN SUNLIGHT. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 149-56(Aug. 1964).

Evidence is presented that soft or low-energy x-agent appears to be coming from sunshine. Thus the sedimentation of neutral red is markedly inhibited when the neutral-red solution is exposed to sunlight. The action of the active factor in sunlight is greatly inhibited by paper shielding, and the shielding effect is strong when the paper is black. Similar effects can be demonstrated with shields of aluminium foil. The effect of the foil varies with its thickness. Harder components can penetrate five sheets of the foil, whereas the softest is checked even by a sheet of white paper. This shows that the factor is exceedingly various in energy. The softest component is found mainly in accompany with sunshine, but harder one can enter a room. On entering the room, its action seems to be greatly changed, or the harder one which can enter the room seems to possess the action which is opposite to that of the softest one. The action of the factor can be demonstrated on cloudy days but not so obviously as on fine days. There is little doubt that such an active factor which is intimately associated with sunlight is a group of soft components of the X-agent. (H.M.G.)

11233 RADIOLYSIS OF HYDROCARBONS. A. V. Topchiev, ed., English Edition Edited by R. A. Holroyd. English Translation. New York American Elsevier Publishing Co., Inc., 1964. 242p. $11.00.

Research on the radiolysis of hydrocarbons carried out at the Radiation Chemistry Laboratory of the Institute for Petrochemical Synthesis of the Academy of Sciences of the USSR during the years 1957 through 1961 is reported. The objective was to elucidate the mechanism of radiolysis of saturated hydrocarbons in both the liquid and solid phases. Topics covered include: physicochemical characteristics of hydrocarbon radiolysis, kinetics of the radiolysis of hydrocarbons, free radicals in the radiolysis of hydrocarbons, radiolysis of alkanes adsorbed on oxide catalysts, energy transfer in the radiolysis of hydrocarbons, some aspects of the theory of hydrocarbon radiolysis, and radiation-thermal cracking of hydrocarbons. (M.C.G.)

11234 EXTENDING THE RANGE OF THE FRICKE DOSIMETER. F. J. Haasbroek (Fruit and Food Tech. Research Inst., Stellenbosch, South Africa). p.60-7 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

The oxygen dependence of the Fricke dosimeter restricts its use to a maximum total dose of 4×10^4 Rads. The possibility of extending its range to higher total doses was investigated. The results indicated that doses up to 10^6 Rads could easily be measured by either supplying oxygen to dosimeter solutions during irradiation, or by employing de-aerated solutions. Both methods necessitate the use of increased ferrous ion concentrations and a G-(Fe^{3+})-value of 8.0 was obtained for the latter method. The reactions are only slightly dependent on the ferrous ion concentration and reproducible results were obtained with both methods. (auth)

11235 THE INTERACTION OF RADIATION WITH SOLIDS. Proceedings of the International Summer School on Solid-State Physics held at Mol, Belgium, August 12-31, 1963. R. Strumane, J. Nihoul, R. Gevers, and S. Amelinckx, eds. New York, Interscience Publishers, 1964. 823p.

Twenty-three papers presented at the International Summer School on Solid-State Physics are given. Separate abstracts were prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 11127, 11128, 11129, 11130, 11236, 11237, 11238, 11239, 11240, 11763, 11764, 11807, 11808, 11809, 11810, 11811, 11812, 12466, 12467, 12468, 12469, 12732, and 12853.

11236 INTRODUCTION INTO RADIATION DAMAGE THEORY. G. Leibfried (Technische Hochschule, Aachen and Kernforschungsanlage, Julich, Ger.). p.1-32 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Neutron irradiation, irradiation with charged particles, and gamma irradiation are considered. Some examples are treated quantitatively and differential and total cross sections for the reactions were determined. Interatomic potentials and recent developments in classical scattering theory are discussed. The simple theory of damage production is presented with a discussion of Frenkel pairs. The spatial distribution of Frenkel pairs produced by one primary reaction is considered. (M.C.G.)

11237 RANGE CALCULATIONS AND CHANNELING. D. K. Holmes (Oak Ridge National Lab., Tenn.). p.33-50 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The spatial extent of radiation damage to crystal lattices and the range of the primary atom were studied. The status of range calculations and experiments are reviewed, and the extent to which interatomic forces are understood is shown. The random, hard sphere, analytical model for range cal-

culations is described and its defects discussed. It was tentatively concluded that energetic atoms move large distances along open directions in crystals. Channeling phenomena are discussed and illustrated in diagrams. (M.C.G.)

11238 DYNAMICS OF ATOMIC DISPLACEMENT PROCESSES. C. Erginsoy (Brookhaven National Lab., Upton, N. Y.). p.51-83 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The displacement of a lattice atom after it has received a kinetic energy pulse, either directly from a particle accompanying the radiation or indirectly as recoil energy when, for instance, the nucleus absorbs a slow neutron, was studied. Results from mathematical simulation of the motion of a large number of interacting atoms in a lattice by means of a large-capacity digital computer were used. Dynamic replacement, propagation of collision chains, and directional dependence of the displacement threshold were investigated. The key mechanism of displacement at low energies was found to be a dynamic replacement by the knock-on. The replacement chains propagated with shock-wave velocities. The threshold energy for displacing an atom was highly dependent on direction. The influence of crystal lattice on cascades was also studied. Dynamic calculations indicated that an actual cubic lattice is highly anisotropic. It was concluded that kinetic energy is not conserved in collisions between a pair of atoms in a crystal lattice since the range of the interatomic forces is not small compared with interatomic distances. The number of defects made during cascades up to 1000 ev were calculated for a knock-on of given direction. (M.C.G.)

11239 FOCUSED COLLISION SEQUENCES AND REPLACEMENTS IN THE COLLISION CASCADE. M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.84-113 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Focusing of collision sequences with a hard sphere model is discussed. High-energy sputtering experiments were used to study cascade collision processes. Deficiencies in the hard sphere model are described. The influence of recoil atoms on assisted focusing in fcc crystals was determined. Focusing in bcc crystals was also studied. Attenuation of simple focused collision sequences and assisted sequences was determined. (M.C.G.)

11240 RADIATION EFFECTS IN IONIC CRYSTALS. W. Dale Compton (Univ. of Illinois, Urbana). p.386-420 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Studies of radioinduced defects in alkali halide crystals are reviewed, with chief emphasis on changes in optical properties caused by the defects. The various types of color centers and mechanisms for their production are discussed. Irradiations and observations at near liquid helium temperature and at room temperature are described. Other ionic crystals discussed briefly include CaF_2, MgO, BaO, and Al_2O_3. (74 references). (M.C.G.)

11241 RECOMBINATION EFFECTS IN THE SCINTILLATION OF LIQUID HELLIUM. Frank E. Moss and Frank L. Hereford (Univ. of Virginia, Charlottesville). 10p. (CONF-651-14)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964).

The role of recombination in the decrease in the intensity of the alpha-particle induced scintillations in liquid helium as the temperature is reduced below the λ point was studied. A decrease in scintillation density was observed upon application of an electric field in the region where the alpha particles stop. Since the field should inhibit recombination, it is suggested that the increased ionic mobility below T_λ may enhance the recombination rate, and that the extraction of ions by an applied field may be enhanced by a rapid radial expansion of the ion column caused by intense local heating. (H.D.R.)

Radiochemistry

Refer also to abstracts 10778, 11170, and 11709.

11242 SPECIFIC ACTIVITY DETERMINATION OF RADIOACTIVE FORMIC ACID. Othmar Gabriel (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). Anal. Biochem., 10: 143-7(Jan. 1965).

Tritiated formic acid and dibromoacetophenone were used to prepare p-bromophenacylformate. Derivatives of the compound were isolated by thin-layer chromatography and characterized. Chromatographic data, melting points, and extinction coefficients of the purified p-bromophenacyl derivatives are tabulated. The accuracy of specific activity measurements is documented. (H.M.G.)

11243 RECORDING RADIOACTIVITY IN ELUATES. C. P. Lloyd-Jones and E. J. Skerrett (Univ. of Bristol, Eng.). Analyst, 89: 782-7(Dec. 1964).

An apparatus is described, which provides a reliable means of automatically recording the distribution of radio activity in chromatographic eluates. A printed record is made of the radioactivity of the eluate flowing into each tube of the fraction collector, and the number of the eluate fraction. The apparatus can be used in conjunction with any turntable-type fraction collector, flow detector, and scaler by inserting a relay in the fraction collector and an output socket in the scaler. (auth)

11244 SPECIFIC TRITIATION OF OXYTOCIN BY CATALYTIC DEIODINATION. Yuko Agishi and Joseph F. Dingman (Peter Bent Brigham Hospital, Boston and Harvard Medical School, Boston). Biochem. Biophys. Res. Commun., 18: 92-7(Jan. 4, 1965).

A method is described for the preparation of tritium-labeled oxytocin by catalytic deiodination. The radiochromatographically homogeneous ^{3}H-oxytocin had a very high bioactivity after 1000 tube countercurrent distribution. (P.C.H.)

11245 THE PURIFICATION OF POLYNUCLEAR HYDROCARBONS TRITIATED BY THE WILZBACH PROCEDURE. William Lijinsky and Humberto Garcia (Chicago Medical School and Univ. of Chile, Santiago). Biologica (Santiago), 35: 135-43(Dec. 1963).

A 500-mg sample of three carcinogenic polynuclear hydrocarbons (benzo(a)pyrene, 20-methylcholanthrene, and 7,12-dimethylbenz(a)anthracene) were exposed to 15 C of tritium gas for 2 weeks and the products examined by chromatography. The purified polynuclear hydrocarbons were studied chemically to ascertain the distribution of T within the molecule. The yields of the crystallized polynuclear hydrocarbons were as follows: benzo(a)pyrene 318 mg (81%), 20-methylcholanthrene 369 mg (92%), and 7,12-dimethylbenz(a)anthracene 354 mg (92%). All had sharp melting points and molar absorptivities which agreed with published values. Exchange of T for H occurred preferentially at certain active sites in the polynuclear hydrocarbon molecule, these being the most favorable positions for substitution. This was not true for 7,12-dimethylbenz(a)anthracene, in which the most active positions are blocked. Here, the distribution of T appeared to be random, since the conversion of this compound to the 5,6-quinone by reaction with osmium tetroxide reduced the radioactivity by the theoretical amount. (BBB)

11246 RAPID METHODS FOR THE DETERMINATION OF ^{14}C-COMPOUNDS IN THE GAS PHASE. F. Drawert, A. Rapp, A. Ziegler, O. Bachmann, and H. Steffan (Forschungs-Institut fur Rebenzuchtung Geilweilerhof, Siebeldingen, Ger.). Chem. Ingr. Tech., 35: 853-5(1963). (In German)

The separation and estimation of vaporizable ^{14}C compounds are carried out by a combination of gas chromatography and proportional gas counting. The technique is recommended because of ease of combination of its elements, applicability to continuous monitoring, and its advantages over scintillation counting: high resolving power of gas chromatography, ability to convert fractions into similar counting forms, high impulse yield of gas counters,

simpler, less destructible method than scintillation at comparable sensitivity, smaller deviations. An apparatus for this purpose is illustrated and described. A combination of a combustion flask and a simple vacuum apparatus for the determination of substances only vaporized with difficulty is discussed. The apparatus for combustion and absorption and a decomposition apparatus are illustrated, and the procedure for measurement of aliquots of the absorption solution is outlined. An analysis takes 30 to 45 min; to decrease waiting time during evacuation and counting, two decomposition apparatuses are mounted next to each other and connected to the same oil pump. (BBB)

11247 GAS RADIO-CHROMATOGRAPHIC ANALYSIS OF HYDROGENATION PROCESSES, RESIDUAL ACTIVITIES OF SEPARATION COLUMNS, ESTERIFICATIONS, EXTRACTIONS AND THE METABOLIC EFFICIENCY OF YEAST THROUGH THE USE OF AN APPARATUS ON THE UNIT PRINCIPLE. Friedrich Drawert, Adolf Rapp, and Herbert Ullemeyer (Forschungs-Institut fur Rebenzuchtung Geilweilerhof, Siebeldingen, Ger.). Chemiker Ztg., 88: 379-84(1964). (In German)

The combination of a reactor unit with gas chromatography and radiation detection units for gas radio-chromatographic detection of various samples is described and illustrated. The instrument combination should also include a gas chromatograph with two thermostats, two injection ports, two flow-rate controls, two thermal conductivity detectors, a flame ionization detector with multiplier and control unit, a temperature regulator and recorder. The reactor unit connects this gas chromatography unit with the radiation counter. The latter includes an electronic clock, an impulse counter, a mean value meter, a high voltage (5 kv) generator, a discriminator with motor drive, a linear amplifier, and a printer. Applications for the apparatus include the following examples: hydrogenation studies of ^{14}C-acetylene over Raney Ni and Pd; direct analysis of the esterification of fatty acids with BF_3 and methanol, using ^{14}C-acetic acid as the example; residual activities of columns through which radioactive samples had been passed; extraction of ^{14}C-ethanol from water by ether; production of ^{14}C-ethanol by several yeasts from various ^{14}C diets. (BBB)

11248 RESEARCH IN THE FIELD OF NUCLEAR CHEMISTRY AND APPLICATIONS OF RADIOSOTOPES IN THE HUNGARIAN CHEMICAL INDUSTRY. Gabor Foldiak (Inst. for Isotopes, National Atomic Energy Commission, Budapest). Magy. Kem. Lapja, 19: 397-9(Aug. 1964).

The Institute for Isotopes produces approximately 260 types of isotope preparations (140 of these organic). Other organizations also produce specialized types of labeled compounds. These include: the Central Research Institute for Chemistry at the Hungarian Academy of Sciences (Magyar Tudomanyos Akademia Kozponti Kemiai Kutato Intezete), the Reanal Fine Chemical Works (Reanal Finomvegyszergyar), and the Frederic Joliot-Curie Research Institute for Radiation Biology and Radiation Hygiene (Frederic Joliot-Curie Sugarbiologiai es Sugaregeszsegugyi Kutatointezet) [locations not given]. Current research projects and applications of radioactive isotopes in Hungary were discussed. (auth)

11249 A DEVICE FOR HOLDING AND REPLACING AMPULES WITH LIQUID RADIOACTIVE ISOTOPES. B. M. Koval (Borislav Inter-Regional Goiter Prevention Dispensary, L'vov). Med. Radiol., 9: No. 9, 88(Sept. 1964). (In Russian)

The currently available tools used for removing ampoules containing radioactive liquids from behind shield or otherwise handling them are poorly designed and result in the exposure of the operator to unnecessarily high doses of radiation. In order to remedy this situation, a vacuum-operated remote-handling device was built. It contains a handle with a long Al rod, carrying a rubber hose connected to a balloon. A fingerlike holding device can be controlled by the evacuation of the balloon, allowing it to grab ampoules weighing up to 100 g; the ampoule can thus be conveniently handled without danger to the operator. By means of suitable attachments, the device may be adapted to handle various sizes and shapes. The new tool increases safety in radiological laboratories. (TTT)

11250 THE TECHNIQUE OF MEASURING LOW ACTIVITIES. E. P. Storozhenko. Med. Radiol., 9: No. 10, 85-90 (Oct. 1964). (In Russian)

The methods used for measuring very low-level activities are reviewed. Shielding must be provided to protect the natural background activity due to the presence of ^{238}U, ^{232}Th and their daughters, ^{40}K and to a much lesser extent, ^{124}Sn, ^{147}Sm, ^{176}Lu, ^{138}La, ^{14}C, ^{3}He, ^{87}Rb and ^{187}Re. Usually Pb is used for shielding. The primary cause of the activity of this metal is due to the presence of ^{210}Pb which has a half life of 22 years; therefore, the activity of Pb prepared during the 16th century is an order of magnitude lower than that of a recently prepared material. The activity of mica, due to its 8 to 10 % K_2O content may reach $6.55 \cdot 10^{-8}$ C/kg; ^{40}K is also responsible for the activity of glasses. Many materials became contaminated by the fission fragments resulting from atomic explosions: the stainless steel fabricated before World War II is much less active than the recently prepared material which contains ^{106}Rh and ^{106}Ru. All these materials affect the measurement of very low activities. In addition, the cosmic radiation and its interaction with the elements contained in the atmosphere must be taken into account. The activity of the Pb and cast iron used for shielding may be absorbed by Hg and Bi. The operating surface of the measuring instruments must be increased in order to use them for low-level determinations. More recently, specially designed liquid scintillation counters have been adapted for this purpose. The technique used involves the dissolution of the material studied in the liquid of the scintillator; suspensions have been also used with good success. Coincidence of two photomultipliers operated by the same scintillator was used to reduce the noise level. (TTT)

11251 RESEARCHES ON GAS TRITIUM FIXATION. PART I. S. Watanabe. Meidensha Jiho, 44: 67-70(Oct. 1962). (In Japanese)

Properties of tritium are discussed. Its advantages for use as a tracer are outlined. (M.C.G.)

11252 PREPARATION OF CARRIER-FREE ^{228}Ac ($MsTh_2$). K. S. Bhatki and J. P. Adloff (Centre de Recherches Nucléaires, Strasbourg). Radiochim. Acta, 3: 12 (Nov. 1964).

A procedure is described for the preparation of pure ^{228}Ac ($MsTh_2$) from ^{228}Ra ($MsTh_1$). After initial purification of ^{228}Ra from ^{228}Th, the sample is left for a month for ^{224}Ra and its daughters to decay completely. After this period, the separation of ^{228}Ac is straightforward. Using Dowex 50 × 8 resin and dilute nitric acid as eluting solution, ^{228}Ac is obtained in high specific activity and in carrier free form in a reasonably short time. Rapid milking of ^{228}Ac can be achieved daily by the use of 0.5 M ammonium-glycolic or an ammonium-α-hydroxyisobutyric solutions of pH about 4. (auth)

11253 THE PREPARATION OF HIGH-SPECIFIC-ACTIVITY COPPER 64. K. Fritze (McMaster Univ., Hamilton, Ont., Can.). Radiochim. Acta, 3: 166-7(Nov. 1964).

Preparation of ^{64}Cu by the $^{64}Zn(n,p)^{64}Cu$ reaction in a swimming pool reactor is described. (J.R.D.)

11254 PREPARATION OF CARRIER-FREE RHODIUM FROM IRRADIATED PALLADIUM. M. Induni de Rojas (Comision Nacional de Energia Atomica, Buenos Aires). Radiochim. Acta, 3: 167-8(Nov. 1964).

Preparation of ^{106}Rh in a synchrotron by the reactions $^{106}Pd(d,2p)^{106}Rh$ and $^{108}Pd(d,\alpha)^{106}Rh$ is described. (J.R.D.)

11255 TRITIATION OF STEROIDS BY EXCHANGE WITH TRITIATED ALCOHOLS. I. Weisz, T. Gosztonyi, V. Kemeny, and J. Marton (National Atomic Energy Commission, Budapest). Tetrahedron Letters, No. 2, 69-71 (1964).

Studies showed that tritium exchange between certain steroids and aliphatic alcohols containing tritium in their hydroxyl groups can take place without the presence of any basic catalysts. Thus, 500 mg of progesterone was dis-

solved in 10 ml of n-amyl alcohol and 3 ml of HTO (10 mC/ml) and fluxed for 2 hrs. The products were separated by chromatography and then recrystallized. The pure compound showed a constant specific activity of 3400 cpm/mg. The specific activity of progesterone did not decrease during boiling for one hr in ethanol or 15 min in methanol-water in the presence of sodium carbonate, but it decreased to about one-third by boiling in the same solution for five hr. The results showed that the remaining tritium is most probably located in positions other than the α-methylene groups to the carbonyl function. By repeating the labeling procedure twice the specific activity of progesterone sample rose up to 10,800 cpm/mg. This spontaneous exchange reaction may be promoted by alkaline carbonates or in case of anhydrous tritiated ethanol or amyl alcohol either by alkoxide ions or by aluminum oxide. This tritiated progesterone could be converted to tritiated corticosterone and aldosterone by incubation with rat adrenal gland. Similar results were achieved with cholesterol and hydrocortisone. (TCO)

11256 SYNTHESIS OF GLUCOSE-3,4-^{14}C OF HIGH SPECIFIC ACTIVITY. Franz Fiedler and Achim Trebst (Technische Hochschule, Munich). Z. Naturforsch., 19b: 395-7(May 1964). (In German)

The enzymic synthesis of glucose-3,4-^{14}C of high specific activity from $^{14}CO_2$ and ribulose-diphosphate and via phosphoglyceric acid and fructose-diphosphate is described. (auth)

11257 THE LABELING OF TYROSINE DERIVATIVES WITH ^{131}I DIRECTLY ON CHROMATOGRAPHY PAPER. A. Van Zyl, B. Wilson, and D. Arbuckle (Univ. of Cape Town). p.106-17 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

A simple and rapid technique for the iodination of tyrosine and labeling of iodotyrosines with ^{131}I is described by which the labeling takes place directly on Whatman No. 1 filter paper immediately before chromatography. The optimum oxidizing conditions for the most effective labeling appear to be a mixture of dilute hydrogen peroxide and elemental stable iodine in an acetate buffer of pH 5. Under such conditions monoiodotyrosine and diiodotyrosine were labeled. The method consists of the application of microgram quantities of the amino acids on to chromatography paper, followed by chromatographically pure ^{131}I and by the oxidizing agents. With as little as 50 μC ^{131}I per 25 mg of tyrosine, radiospecific activities of about 6 μC/μg of monoiodotyrosine and about 0.9 μC/μg of diiodotyrosine were obtained. With increasing concentrations of stable elemental iodine in the oxidizing mixture, specific radioactivities became correspondingly less. Thyronines require more drastic oxidizing agents for ^{131}I-labeling than tyrosines and were labeled only after the addition of dilute sulfuric acid to the oxidizing medium. When the starting material contains a benzene ring substituted with two iodine atoms, exchange takes place, but with less than two iodine atoms exchange and iodination seem to occur. The oxidizing medium determines the extent of these reactions. (auth)

Separation Processes and Procedures

11258 (EUR-2169.e) COMPLEX FORMATION IN TERTIARY AMINE EXTRACTION OF TRIVALENT METALS. W. Mueller (European Atomic Energy Community); J. Fuger (Institut Interuniversitaire des Sciences Nucléaires, Brussels); and G. Duyckaerts (Liege. Université). 1964. 20p. (CONF-640905-1). Dep.(mn).

From 8th International Conference on Coordination Chemistry, Vienna.

In an attempt to gain an understanding of factors affecting the extraction of transplutonium elements by tertiary amines, the equilibria between hydrochloric acid and organic solutions of trilaurylamine have been studied and the amine extraction of ferric chloride in macro- and tracer amounts has been compared with the extraction of trivalent actinides and lanthanides. Complexes containing 2 molecules of amine salt per atom of the metal are formed either when trivalent actinides and lanthanides are extracted from concentrated chloride solutions or when trivalent iron is extracted from dilute hydrochloric acid or lithium chloride solutions; a 1:1 complex is observed for the extraction of ferric chloride from concentrated hydrochloric acid or chloride solutions. The 2:1 complexes are assumed to result from association of a 1:1 complex with a molecule of amine hydrochloride. The decrease in metal extraction at high chloride concentration and with increasing acid activity is due to competition between the extraction of the metal and the extraction of excess hydrogen chloride, the latter leading to amine dihydrochloride. Efficient separation of trivalent actinides from lanthanides is possible, as well as group separation of americium-curium from californium-einsteinium. From studies of the diluent influence on the equilibria between amine and hydrogen chloride and on metal extraction, it is concluded that the diluent-amine salt interaction decreases in the order: chloroform, aromatic hydrocarbons, cyclohexane. (auth)

11259 (HW-83818) ANALOG COMPUTER SIMULATION OF A PULSED EXTRACTION COLUMN. R. D. Benham and N. P. Wilburn (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. Dep.; $2.00(OTS).

Several advanced computer techniques were used successfully to determine the "best" fit of a mathematical model to a set of physical data obtained from a pulsed solvent extraction column. The "best" values of the model parameters were determined by comparing the "smoothed" physical data to corresponding quantities calculated from the model. The difference was squared and integrated along the height of the column. The "best" values of the parameters were those that produced a minimum of the error-squared integral. A random automatic searching technique was used on an analog computer to determine the "best" values of the model parameters. For one model the simulation consisted of two parts, where the first part automatically calculated the initial conditions for the second part. An IBM 7090 data reduction system was developed to automatically scale and calculate potentiometer settings for different sets of data. A new concept in dynamic simulation was used. A digital computer program was used to check the results of the analog study. This MIDAS program (Modified Integral Digital Analog Simulation) allows programming the IBM 7090 computer in much the same way the analog computer is programmed. The MIDAS program was used only as an independent check on the analog results. (auth)

11260 (NP-14662) SORPTION OF HEAVY RADIOACTIVE ISOTOPES FROM LIQUID RADIOACTIVE WASTES ON PEAT. I. OUTLINE OF CHEMICAL AND SORPTIVE CHARACTERISTICS OF PEAT. Bibliographical Review. Andrzej Kostyrko and Krzysztof Zarnowiecki (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Dec. 31, 1963. IAEA Contract 203-RB. 18p. Dep.(mn).

The constituents of peat and their general properties are surveyed: humic acids, lignin, cellulose, and hemicelluloses. The factors determining the mechanism of sorption processes on peat are outlined. Finally, investigations on the use of peat for uranium sorption and waste decontamination are reviewed. (D.L.C.)

11261 (NP-14668) SORPTION OF HEAVY RADIOACTIVE ISOTOPES FROM LIQUID RADIOACTIVE WASTES ON PEAT. II. INTERNATIONAL ATOMIC ENERGY AGENCY 203/RB RESEARCH CONTRACT SEMIANNUAL PROGRESS REPORT. Bibliographical Review. Krzysztof Żarnowiecki, Andrzej Kostyrko, and Małgorzata Holsztyńska (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Dec. 31, 1963. 30p. Dep.(mn).

Studies were made on three different peat types for use in decontamination processes. The effects of pH on the sorption of ^{90}Sr + ^{90}Y and ^{137}Cs were studied. The reten-

tion of radioactive ions on peat was studied for the following ions: Na^+, Co^{2+}, Zn^{2+}, Sr^{2+}, Y^{3+}, Ru^{3+}, Cs^+, and Tl^+, and distribution coefficients and decontamination factors were calculated. Different ways of carrying out the decontamination (column, batch, stirring) are compared. (D.L.C.)

11262 (ORNL-TM-657) SEPARATION OF CERIUM-144 FROM OTHER RARE EARTHS BY ELECTROLYTIC OXIDATION AND DIFFERENTIAL EXTRACTION. R. E. McHenry (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Cerium-144 was separated with 99.75% yield on a continuous basis from other rare earth fission products by electrolytic oxidation of the cerium(III) ion to the cerium(IV) ion, followed by differential extraction with di(2-ethylhexyl)-phosphoric acid in Amsco. (auth)

11263 (ORNL-TM-896) AN AIR-PULSED LABORATORY MIXER-SETTLER. R. E. McHenry and J. C. Posey (Oak Ridge National Lab., Tenn.). Sept. 1964. Contract W-7405-eng-26. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A new all-glass laboratory scale air-pulsed mixer-settler was designed, constructed, and tested under a wide variety of operating conditions. This contactor was designed for processing of radioactive materials and has no moving parts. The interface stability, stage efficiency, and flow capacity were evaluated. Very high interface stability and stage efficiency were found to be characteristic of this mixer-settler. Flow capacities were correlated with the density difference in the light and the heavy phases and with resistance to flow. (auth)

11264 (ORNL-TM-937) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, MAY 1964. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 42p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The most recent configuration of the stacked-clone contactor, a solvent extraction contactor being developed for use in very high radiation fields, shows a stage efficiency of 80% and a throughput of 3700 ml/min extracting uranyl nitrate from a 1M sodium nitrate solution into 18% TBP in Amsco, or stripping with the same system. Data from over 200 runs are analyzed. Two 10-liter batch leaching runs were made with ½-in. sheared lengths of ThO_2-3% UO_2-stainless steel fuel rods. A recovery of 99% required 16 hrs when the final solution was 215 g/liter Th and 9M H^+, and required 18 hrs when the final solution was 250 g/liter Th and 8.2M H^+. Air sparging was used to suspend the fines released from the sheared pieces. The performance of pellets of NaF during the repetitive sorption-desorption of UF_6 was studied for the Volatility Processing program. It was found that the capacity decreased and the specific surface area increased with repeated use. The pellets also degraded by powdering, with the rate of degradation increasing with the initial void fraction. The experimental filling rates during waste calcining run R-83, using a 16-in.-diam pot, closely followed the calculated rates from the radial deposition model. The pot was 95% full after 94 hrs. It was necessary to stop the run at that time because a hole developed in the pot wall. (auth)

11265 (RT/GEO(64)-14) ORIENTAMENTI ATTUALI NEL TRATTAMENTO DEI MINERALI D'URANIO IL PUNTO DOPO LA III CONFERENZA INTERNAZIONALE DI GINEVRA SUGLI USI PACIFICI DELL'ENERGIA NUCLEARE. (Current Orientation on the Treatment of Uranium Minerals. An Issue After the Third International Geneva Conference on Peaceful Uses of Nuclear Energy). G. Rinelli (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Oct. 1964. 15p. (CONF-641006-1). Dep.(mn).

From 48th Meeting of the Italian Society for the Progress of Science, Cagliari-Sassari, Italy.

Nowadays the trend in the uranium ores processing is determined by the necessity of cutting production costs in the exploitation of the low-grade reserves, which represent the source for the future feeding of electronuclear plants. The greatest improvement has been given to the research on the methods of natural leaching which allow one to save 30–35% in respect to the cost of the conventional methods for uranium dissolution. As regards proper hydrometallurgical operations, researches are carried out with the purpose of the production of final substances of the highest nuclear purity, which may be different from the traditional yellow cake. (auth)

11266 (AEC-tr-6227/3(p.201-13) CHROMATOGRAPHIC SEPARATION OF RARE EARTHS ON PAPER TREATED WITH di-n-BUTYLPHOSPHATE. N. Cvjetićanin. Translated from Bilten Inst. Nukl. Nauke "Boris Kidric," 15: 201-13(1964).

The chromatographic behavior of rare earths on paper treated with di-n-butylphosphate was investigated. Hydrochloric acid in concentrations of 0.2 to 10 M was used as the elution agent. The dependence of the R_f values on the molarity of the acid and on the ion atomic numbers are given. On the basis of the results obtained, the possibility of the interseparation of the elements of the rare earth group is suggested. (auth)

11267 CONTRIBUTIONS TO THE SEPARATION OF YTTRIUM. PART II. P. Spacu, Maria Mavrodin, Elena Antonescu, and Silvia Serban (Univ. of Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Chim., 10: 357-62 (1962). (In Rumanian)

A method is described for separating Y from La and Ce, using chlormandelic acid as a precipitating agent and glycocol, phenylamine, and tryptophene as complexing agents. It was ascertained from the studies carried out that the leading part in this separation is played by the difference in solubility between the yttrium chlormandelate, practically insoluble in water, and the La and Ce chlormandelates. (auth)

11268 CONTRIBUTIONS TO THE SEPARATION OF YTTRIUM FROM PRASEODYMIUM AND NEODYMIUM. P. Spacu, Elena Antonescu, Silvia Serban, and Maria Mavrodin (Inst. of Inorganic Chemistry, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Chim., 11: 411-14(1963). (In Romanian)

A quantitative method for separation of Y from Pr and Nd is presented. It consists in precipitating with chloromandelic acid at pH 5.5 and solving Pr and Nd chloromandelates in 20% glycine. Excellent results were obtained by working with Y_2O_3 in amounts up to 12 mg. (auth)

11269 PROCESSING OF REACTOR FUEL MATERIALS BY PYROMETALLURGICAL METHODS. S. Lawroski and L. Burris, Jr. (Argonne National Lab., Ill.). At. Energy Rev., 2: No. 3, 3-69(1964).

The principles of pyrometallurgical processes are discussed and the history of pyrometallurgical process development is reviewed briefly. Emphasis is given to recent developments and especially to impending demonstrations of these processes for recovery of fuel materials discharged from Argonne National Laboratory's Second Experimental Breeder Reactor (EBR-II). Fuel from this reactor will be processed and re-fabricated into new fuel elements for return to the reactor in an adjacent processing plant, known as the EBR-II Fuel Cycle Facility. 191 references are included. (P.C.H.)

11270 ION EXCHANGE RESINS. PRINCIPLES OF UTILIZATION. Bernard Tremillon (Faculte des Sciences, Paris). Bull. Inform. Sci. Tech. (Paris), No. 85, 5-12(July-Aug. 1964). (In French)

The principles for utilization of ion exchange resins are summarized by the presentation of the various aspects of problems caused by their utilization. Their nature and functioning are described. Resin columns, the concept of equivalent theoretical plateau, and counter-current columns are considered. (J.S.R.)

11271 COMPLEXING RESINS. PROPERTIES AND APPLICATIONS. Robert Rosset (Ecole Superieure de Physique et de Chimie, Paris). Bull. Inform. Sci. Tech. (Paris), No. 85, 13-23(July-Aug. 1964). (In French)

The structure, physical properties, chemical properties, and utilization of phosphonate and aminodiacetate resins are reviewed as typical of complexing resins. They were used because of their well-defined characteristics and their commercialization. (J.S.R.)

11272 THE UTILIZATION OF ION EXCHANGERS IN SOLVENTS OTHER THAN WATER. Claude Poitrenaud. Bull. Inform. Sci. Tech. (Paris), No. 85, 25-8(July-Aug. 1964). (In French)

The conditions that must be fulfilled by the resin and solvent in order that ion exchange can take place are listed and described. The effect of the solvent on the exchange equilibrium is discussed. (J.S.R.)

11273 UTILIZATION OF ION EXCHANGE RESINS IN THYROID PHYSIOLOGY. D. Comar (Service Hospitalier Frederic, Joliot, Orsay, France). Bull. Inform. Sci. Tech. (Paris), No. 85, 41-4(July-Aug. 1964). (In French)

Methods for the radiochemical separation of iodine in a biological liquid and the separation of different iodated organic fractions in blood plasma are described. Results are tabulated. (J.S.R.)

11274 ASPECT OF THE TECHNIQUES USED IN THE INDUSTRIAL APPLICATIONS OF ION EXCHANGE COLUMNS. R. Platzer and C. Blain. Bull. Inform. Sci. Tech. (Paris), No. 85, 49-80(July-Aug. 1964). (In French)

The characteristics and techniques of fixed-bed and moving-bed ion exchange columns are described. The research undertaken in France on the technology of the moving bed is summarized. The treatment of mixed beds of anionic and cationic resins is discussed. Industrial developments of moving-bed ion exchange columns are illustrated. (J.S.R.)

11275 CONTINUOUS SEPARATION OF LITHIUM AND SODIUM ON ION EXCHANGE RESIN IN GRAVITY MOVING BED. R. Artaud and B. Mazoyer. Bull. Inform. Sci. Tech. (Paris), No. 85, 81-96(July-Aug. 1964). (In French)

The principle of ion-exchange separation of lithium and sodium on a moving-bed ion-exchange resin is summarized, and a theoretical study of the separation is given. The results obtained on a pilot column showed that almost pure lithium (less than 200 ppm in Na/Li in weight) can be obtained. (J.S.R.)

11276 SOLVENT EXTRACTION AND SEPARATION OF EUROPIUM(III) AND TERBIUM(III) FROM URANIUM(VI) BY MONOOCTYL ANILINOBENZYLPHOSPHONATE. M. J. Herak and V. Jagodić (Institut "Ruder Boskovic", Zagreb). Croat. Chem. Acta, 36: 51-8(1964).

The solvent extraction behavior of Eu(III) and Tb(III) between aqueous solutions and a ligroin solution of monooctyl α-anilinobenzylphosphonate was investigated. The distribution studies were carried out using the radionuclides ^{152}Eu and ^{160}Tb as tracers. Uranium was determined spectrophotometrically. The effect of varying the concentration of extractant in the organic phase and of varying the hydrogen ion concentration of the aqueous phase was studied. Chloride, perchlorate, nitrate, and sulfate solutions were employed as aqueous phases. The metal-ligand ratios of the extractable Eu(III) and Tb(III) complexes were determined from log-log plots of the partition coefficients vs. the concentrations of extractant in the organic phase and hydrogen ion concentration in the aqueous phase. Conditions for the separation of Eu(III) and Tb(III) from U(VI) are given together with the separation coefficients, which were found to range from 10^3 to 10^4. The possibility of back-extracting the extracted uranium is discussed. (auth)

11277 PRECIPITATION OF PLUTONIUM TRIFLUORIDE. Glenn A. Burney and Frank W. Tober (E. I. du Pont de Nemours & Co., Aiken, S. C.). Ind. Eng. Chem., Process Design Develop., 4: 28-32(Jan. 1965).

A process was developed to precipitate PuF_3 from plutonium nitrate solution. Large crystals are precipitated by controlling the ratio of nitric acid to hydrofluoric acid to maintain the required PuF_3 solubility during addition of the plutonium nitrate solution to the precipitant. The solubility of the trifluoride is decreased prior to filtration by lowering the ratio of nitric acid to hydrofluoric acid. The solubility product of PuF_3 is $2.4 \pm 0.4 \times 10^{-16}$. Losses of Pu to the filtrate are minimized by adding ascorbic acid to the feed immediately before precipitation to reduce Pu(IV) and adding sulfamic acid to decrease the rate of oxidation of Pu(III). The PuF_3 is easily filtered and dried to the anhydrous salt and is pure enough for subsequent reduction to plutonium metal. (auth)

11278 DISSOLUTION OF SODIUM FROM SODIUM-BONDED URANIUM CARBIDE FUEL PIECES. Louis Silverman and Edward L. Reed (Atomics International, Canoga Park, Calif.). Ind. Eng. Chem., Process Design Develop., 4: 32-5(Jan. 1965).

Several procedures were investigated for the dissolution of Na from Na-bonded UC nuclear fuel pieces. Two are described. In the first, the clad UC pieces are immersed in ethylene glycol n-monobutyl ether until sodium solution (H_2 evolution) has ceased. The slugs are then washed in clean glycol, suspended in a trichloroethylene vapor bath, cooled, and dried in vacuum at 100°C, and then at approximately 500°C. Na-bonded UC, cleaned in this manner, has been rebonded successfully. In the alternative procedure, butyl bromide reacts with the Na at 80°C to form NaBr, some of which is highly adherent to the carbide surface. Dimethylformamide, at 140°C, dissolves all of the adhering NaBr, and in turn is completely evolved in vacuum. The butyl bromide technique is particularly attractive in related processes where evolution of H_2 is not permissible. (auth)

11279 STAGEWISE CALCULATION FOR THE SOLVENT EXTRACTION SYSTEM MONAZITE RARE EARTH NITRATES–NITRIC ACID–TRIBUTYL PHOSPHATE–WATER. Brooks M. Sharp and Morton Smutz (Ames Lab., Ames, Iowa). Ind. Eng. Chem., Process Design Develop., 4: 49-54(Jan. 1965).

Using single-stage equilibrium data plus the assumption of mutual immiscibility of water and tributyl phosphate (TBP), a calculation method was developed to give the stagewise conditions in a cascade of equilibrium stages with four rare earth nitrates and nitric acid present as solutes in the flow streams. The method was checked by a series of simulated column experiments. The agreement between predicted and experimental stagewise conditions was considered reasonable, and the method is considered useful for engineering work. The calculation and correlation methods developed should be applicable to systems with a larger number of rare earth solutes and possibly to some other multisolute systems containing a series of chemically similar solutes. (auth)

11280 CHROMATOGRAPHIC BEHAVIOUR OF LIGHT RARE EARTHS ON ANION-EXCHANGE PAPER IN NITRATE–METHANOL SYSTEMS. E. Cerrai and C. Triulzi (CISE, Milan). J. Chromatog., 16: 365-75(Nov. 1964).

The chromatographic behavior of rare earths from La to Gd was investigated in HNO_3–methanol systems on the anion-exchange paper DE-20. The possibility of separation of two or more rare earths from each other was shown as a consequence of the favorable effect of high methanol concentrations on selectivity. A comparison was also made with results obtained by elution under the same conditions on pure cellulose CRL/I paper. This paper possessed only limited adsorption properties and did not show any selectivity toward different rare earths. The fact that in the liquid–liquid extraction system with the liquid anion exchanger tri-n-octylamine no rare earth adsorption occurs into the organic phase suggests that the adsorption and selectivity shown by the anion-exchange paper is not attributable to a pure anion-exchange process. (auth)

11281 REVERSED-PHASE PARTITION CHROMATOGRAPHY WITH DI-(2-ETHYLHEXYL) ORTHOPHOSPHORIC ACID AS THE STATIONARY PHASE. PART I. SEPARATION OF RARE EARTHS. R. J. Sochacka and S. Siekierski (Inst. of Nuclear Research, Warsaw). J. Chromatog., 16: 376-84(Nov. 1964).

Reversed phase partition chromatography with HDEHP retained on kieselguhr as the stationary phase was applied

to the separation of rare earths. The influence of the amount of HDEHP on the height of the plate was studied. Up to 10% of HDEHP (with respect to the amount of kieselguhr) the height of the plate is about 0.33 mm which makes possible very clear separations of adjacent rare earths at room temperature. No gradient elution technique was found necessary for the separation. The height of the plate can be decreased to less than 0.2 mm by using a specially selected fraction of kieselguhr. Microamounts of Tb were separated from macroamounts of Er. The amount of Er retained on the column and separated from Tb was found to be proportional to the amount of HDEHP. It was found that the width of the elution peak of heavy rare earths is much greater with HCl than with HNO_3 as eluting agent. (auth)

11282 REVERSED-PHASE PARTITION CHROMATOGRAPHY WITH DI-(2-ETHYLHEXYL) ORTHOPHOSPHORIC ACID AS THE STATIONARY PHASE. PART II. FACTORS AFFECTING THE HEIGHT OF THE PLATE. S. Siekierski and R. J. Sochacka (Inst. of Nuclear Research, Warsaw). J. Chromatog., 16: 385-95(Nov. 1964).

The effects of the rare earth atomic number, the eluting acid, and the flow rate and temperature on the height of the plate in reversed phase partition chromatography with HDEHP as the stationary phase were studied. It was shown that the height of the plate is chiefly determined by the mass transfer between the aqueous and organic phases. In the case of elution of the heavy rare earths with HCl and H_2SO_4 the mass transfer is a slow process because of some slow chemical stage in the overall process of extraction. (auth)

11283 ANION EXCHANGE BEHAVIOR OF RARE EARTH ELEMENTS IN POTASSIUM SULFATE MEDIUM. Hiroshi Hamaguchi, Atsuhiro Ohuchi, Naoki Onuma, and Rokuro Kuroda (Tokyo Kyoiku Univ.). J. Chromatog., 16: 396-402(Nov. 1964).

The anion exchange behavior of rare earth elements as well as Sc and Y in potassium sulfate medium was investigated. Rare earths and Y showed slight adsorption on the strongly basic anion exchange resin Dowex I, X-8, from dilute potassium sulfate solution, while Sc was rather strongly adsorbed on the resin. The distribution coefficients of the rare earth elements were found to increase in a regular way from La to Eu, reaching a maximum at Eu and then decreasing with increasing atomic number. Although the system could not effect the separation of the whole of the rare earth elements in a single elution, the possibility of achieving effective chromatographic separation of selected pairs or groups of rare earth elements on a column, 57 cm long, was demonstrated. (auth)

11284 ION EXCHANGE PROCEDURES. V. SEPARATION OF BARIUM AND RADIUM. Frederick Nelson (Oak Ridge National Lab., Tenn.). J. Chromatog., 16: 403-6 (Nov. 1964).

A cation exchange procedure is described for separating Ba and Ra. Separation is achieved with EDTA solutions of controlled pH. (auth)

11285 REPROCESSING COSTS OF SPENT NUCLEAR FUEL. Libor Kuca (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 10: 372-9(1964). (In Czech.)

The costs of nuclear fuel reprocessing, mainly problems of transporting, dissolving, and extraction of fuel are discussed, as well as the influence of criticality on economical reprocessing and the role of plutonium in a fuel cycle. The more important conceptions of spent fuel and aspects influencing reprocessing plant capacity are evaluated. (auth)

11286 CHEMICAL DISSOLUTION OF GRAPHITE–CARBIDE FUEL ELEMENTS. E. Lopez-Menchero and R. Rometsch (EUROCHEMIC, Mol, Belg.). Neue Tech., 6: 332-8(Dec. 1964).

A reprocessing method for graphite-based fuel elements is discussed. A number of alternative chemical methods for attacking and dissolving graphite, pyrolytic carbon coatings, and silicon carbide layers were tested at Eurochemic. The graphite compacts, amorphous and pyrolytic carbon, and silicon carbide layers in which the carbides of the fissile and fertile elements are included are burned under selected molten salts with oxygen or the oxygen released in the thermal decomposition of nitrogen dioxide. The left residue is leached by mineral acids (nitric with or without fluoride present) and sent to conventional solvent extraction processing cycles. (auth)

11287 PURIFICATION OF HEAVY WATER BY ION EXCHANGE RESIN. Akishige Harada and Yasuo Kurihara (Showa Denko Co., Ltd., Japan). Nippon Genshiryoku Gakkaishi, 6: 690-4(Dec. 1964). (In Japanese)

Heavy water containing 1,100 ppm of deuterized boric acid and other impurities was purified by an ion exchange method using both cation and anion exchange resins. The ion exchange resin used was deuterized to prevent a dilution by light water, because the concentration of heavy water was so high (99.7 at. % D). The optimum linear velocity in the deuterization of resin was determined as 0.3 m/hr. The purification was finished so that the specific resistance of the purified heavy water showed a value higher than 10 MΩ-cm without grading-down of the heavy water. (auth)

11288 THE EXTRACTION OF THORIUM FROM NITRIC ACID SOLUTIONS BY A QUATERNARY AMMONIUM NITRATE (ALIQUAT-336). P. Gerontopulos (SNAM-LRSR, Milan) and L. Rigali. Radiochim. Acta, 3: 122-3(Nov. 1964).

The extraction of Th from HNO_3 solutions into xylene solutions of a quaternary ammonium salt (Aliquat-336) was investigated. Aliquat-336 presents a high affinity for Th with a maximum of extraction in 3 to 4 M HNO_3. The species extracted into organic phase appears to be $Th(NO_3)_6^{2-}$. (auth)

11289 CONTRIBUTION TO THE STUDY OF SULFURIC COMPLEXES OF PLUTONIUM(IV). M. Lucas (Centre d'Etudes Nucléaires, Fontenay-aux-Roses, France). Radiochim. Acta, 3: 126-9(Nov. 1964). (In French)

Using a solvent extraction method the stability constant of the neutral species $Pu(SO_4)_2$ corresponding to the equilibrium $PuSO_4^{2+} + HSO_4^- \rightleftharpoons Pu(SO_4)_{2(aq)} + H^+$ was determined. The value for the constant $\beta_2 = [|Pu(SO_4)_{2(aq)}|\ |H^+|/|PuSO_4^{2+}|\ |HSO_4^-|]$ is 3.8 ± 0.7 at ionic strength μ = 1 and 23° ± 0.5°C. The equilibrium composition of the solution was the following: HNO_3 = 0.5 M; $NaNO_3$ = 0.5 M; Pu(IV) about 10^{-6} M. (auth)

11290 REACTOR FUEL PROCESSING. Volume 7, No. 2. Stephen Lawroski, ed. (Argonne National Lab., Ill.). Spring 1964. $0.70(GPO)(Domestic), $0.90(GPO)(Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 77p. Dep.

Progress in reactor fuel processing is reviewed under the following topics: commercial aspects of fuel processing, research and development on aqueous processing, research and development on nonaqueous processing, waste disposal, and production of uranium, thorium, and plutonium and their compounds. Separate abstracts were prepared for each topic. (M.C.G.)

For abstracts of individual items see: 11291, 11292, 11293, 11677, and 12859.

11291 COMMERCIAL ASPECTS OF FUEL PROCESSING. Reactor Fuel Process., 7: No. 2, 83-7(1964)

Fuel-processing plans and economics of fuel cycles and chemical processing are discussed. (10 references). (M.C.G.)

11292 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. Reactor Fuel Process., 7: No. 2, 88-104 (1964).

Research progress on preparation of fuel for processing, solvent-extraction processes, chemical processing in the transuranic-element program, recovery of neptunium from solvent processes, and plant and equipment design is reviewed. (33 references). (M.C.G.)

11293 RESEARCH AND DEVELOPMENT ON NON-AQUEOUS PROCESSING. Reactor Fuel Process., 7: No. 2, 105-30(1964).

Research progress on volatility processes, pyrometallurgical processes, and other nonaqueous processes is reviewed. (67 references). (M.C.G.)

11294 ELECTROLYTIC REDUCTION OF MELTED POTASSIUM FLUOROZIRCONATE. M.-J. Barbier and J. Cotteret (Faculté des Sciences, Grenoble, France). Rev. Hautes Temp. Refractaires, 1: 41-4(Jan.-Mar. 1964). (In French)

The perfection of suitable operating conditions allows metallic Zr to be obtained by electrolysis of melted potassium fluorozirconate without salt addition. Electrolysis is carried out in a graphite crucible serving as an anode, on an axial cathode of Mo. Provided that the process begins with a bath freed from impurities by pre-electrolysis and under an atmosphere of purified Ar, the Zr is 99.5% pure. In order to study the cathodic process, reversible electrode is used as an anode and the curve representing the variations of the potential difference at the boundary of the cell is plotted as a function of the intensity of the current. The extrapolation of the curve obtained under these conditions permits characterizing a voltage value of the cathodic process. A test of the theoretical evaluation of the voltage of the liquid junction introduced by this electrode put into contact with the bath shows that the order of magnitude is negligible. Comparison of the curves and discussion of the experimental results lead to the conclusion that the intervention of K in the process of Zr formation is improbable. It seems that separation of the metal results from a direct electrochemical reduction, at least at low current densities. (auth)

11295 INVESTIGATIONS ON SEPARATION OF THORIUM FISSION PRODUCTS BY ANION EXCHANGE PAPERS. Renato Barbieri, Giuseppe Rizzardi, and Nuccio Bertazzi (Università, Padua and CNR, Padua). Ric. Sci., Rend., Sez. A(2), 4: 563-6(June 1964). (In Italian)

The technique of chromatographic separation by anion exchange paper was successfully applied to thorium fission products. (auth)

11296 ISOTOPIC EXCHANGE REACTIONS STUDIED BY ELECTRODEPOSITION. NON-RAPID AND MODERATELY RAPID IODIDE EXCHANGES. Per Beronius (Royal Inst. of Tech., Stockholm). Svensk Kem. Tidskr., 76: 646-56(1964).

The development of two electrodeposition methods is reviewed with respect to their use to the study of the kinetics of isotope exchange between organic iodides and iodide ions at half-times ranging from 0.1 sec to several hours. The first method is intended for non-rapid reactions (half-times of a few min to several hr). The second method is designed for moderately rapid reactions (half-times of 0.1 sec to several minutes). The methods show improved precision over earlier separation methods. (N.W.R.)

11297 SEPARATION OF VANADIUM AND URANIUM IN H_2SO_4–HF SOLUTIONS BY MEANS OF AV-17, EDE-10P, AND AN-2F ANIONITES. V. S. Pakholkov and S. E. Simakov. Zh. Prikl. Khim., 37: 2565-9(Dec. 1964). (In Russian)

An analysis of combined V and U sorption from H_2SO_4–HF solutions by AV-17 and EDE-10P anionites showed a satisfactory sorption only for U(IV) and U(V). Furthermore stable and highly sorptive uranyl fluoride complex anions easily displaced V(V) and a complete separation of U(IV) and V(V) was achieved. (R.V.J.)

11298 FLUIDIZED-PACKED BEDS. J. D. Gabor (Argonne National Lab., Ill.). New York, American Inst. of Chemical Engineers, 1964, Preprint 30d, 55p, $0.50. (CONF-641201-12)

From American Institute of Chemical Engineers Annual Meeting, Boston.

Although the addition of fixed packing to a fluidized bed was found to alter bed expansion and pressure drop characteristics, satisfactory fluidization for reactor considerations still existed in the voids of the fixed packing. Lateral solids mixing diffusivities for fluidized-packed beds were correlated by an equation. Mixing of solids in the axial direction was an order of magnitude greater than lateral mixing of solids. Lateral effective bed thermal conductivities were correlated by an equation. Wall heat transfer coefficients for fluidized-packed beds were somewhat lower than for comparable cases of open tube fluidization because of baffling by the fixed packing. Fixed packing surface heat transfer coefficients were increased by an order of magnitude with the addition of fluidized particles. The lateral gas mixing for a fluidized-packed bed reactor could be estimated from packed bed data with allowance for the directional variance in the gas stream caused by nonuniform pressure gradients associated with fluidization. Elutriation rates decreased with increasing amounts of fixed packing. (auth)

11299 METHOD FOR SEPARATING THORIUM AND YTTRIUM VALUES. William Nicholas Vanderkool (to Dow Chemical Co.). British Patent 972,943. Oct. 21, 1964. Filed Oct. 8, 1962.

A process is described for the efficient removal of thorium and yttrium values from U-free aqueous acid solutions. The thorium values are removed from the solution (pH 1.0–2.5) by a contacting treatment with a water-insoluble resin having within its structure nitrogen-containing substituents that form coordinate bonds with the thorium ion. The resin is then rinsed with water and the adsorbed thorium values are eluted from the resin with a mineral acid. The Th-containing eluate may be recycled at least once over the Th-coordinating resin to separate the Th values from the Fe values. The Th-free effluent solution from the initial resin treatment is given a separate contacting treatment with a cation exchange resin to remove and recover the Yt values. Alternate types of water-insoluble resins are suggested. The process is particularly applicable to the removal of Th and Y from the acidic leach liquors of U ores from which the U has been removed. (A.G.W.)

11300 METHOD OF PRODUCING URANIUM CONCENTRATES OF HIGH PURITY. Pierre Mouret, Jean Lebris, Marcelle Kremer, Jean-Jacques Morand, and René Gauthier (to Commissariat à l'Énergie Atomique). German Patent 1,175,211. Aug. 6, 1964. Priority date Aug. 14, 1958, France.

The method developed for preparing uranium concentrates consists of dissolving the uranium ore in sulfuric acid and of precipitating a rough concentrate from the solution with calcium carbonate. A sufficient quantity of sulfuric acid, iron(II) sulfahydrate, and iron(III) sulfate is added to the rough concentrate to transform the uranium entirely. The mixture obtained is treated at a temperature between 100 and 400°C and leached with a neutral, aqueous solution of calcium nitrate. The uranyl nitrate solution is then extracted in a known manner. (Gmelin Inst.)

11301 SEPARATION OF STAINLESS STEEL FROM A NUCLEAR FUEL. H. M. Katz (to U. S. Atomic Energy Commission). U. S. Patent 3,165,377. Jan. 12, 1965.

A wet process that uses a mixture of HNO_3 and H_2SO_4 for removing stainless steel cladding from reactor fuel elements is described. The process may be carried out in stainless steel vessels if the elements are contacted with mild steel to dissipate the cladding and allow the process to continue. (AEC)

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Refer also to abstracts 12139, 12157, 11425, and 11684.

11302 (AERE-M-1504) FRESH WATER FROM SEA WATER—A SURVEY OF LARGE SCALE EVAPORATION PROCESSES. I. H. Newson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1964. 25p. Dep.; $0.70(BIS); 3s.6d.(HMSO).

The efficiencies of modern large scale evaporation plants are discussed together with their technical limitations, problems, and costs. The most urgent research problems in this field lie in the prevention of scale deposition at temperatures above 250°F and in improving heat transfer and boiling under conditions of small temperature differences. (auth)

11303 (CEA-R-2460) ELIMINATION ET REPARATION D'ENCEINTES ACTIVES. (The Disposal and Repair of Radioactive Enclosures). Pierre Boutot (France. Commissariat à l'Énergie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). Aug. 1964. 18p. Dep. (mn).

An account is given of two years experience with the method for dismantling which is carried out inside sealed enclosures after the contamination has been fixed. (D.L.C.)

11304 (GAMD-3058) HTGR LOW-COBALT VALVE SEAT MATERIAL GALLING TESTS. W. L. Wyman (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mar. 23, 1962. Contract AT(04-3)-314. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Tests were conducted to determine the galling and sticking characteristics of several candidate hardfacing materials for the seats in the HTGR reactor valves. Of the materials tested, only Type 308 stainless steel exhibited interface action (galling). Colmonoy 5 to Colmonoy 6 is considered to be the best combination. (D.L.C.)

11305 (HRD-63736) REDUCING THE STRUCTURAL VULNERABILITY OF FOOD-PROCESSING PLANTS TO THE BLAST AND THERMAL EFFECTS OF NUCLEAR WEAPONS. Randle H. Powley and Robert I. Young (Hoff Research and Development Labs., Inc., Cleveland). Apr. 30, 1964. Contract OCD-PS-64-14. 248p. (AD-603217)

This report studies the reduction of the structural vulnerability of representative food processing plants in the United States to the blast overpressures and thermal energy released by nuclear weapons. It develops hardening measures for strengthening points or areas of critical weakness. These apply generally to pre-attack protective planning in all industries. Potential damage is analyzed, from field-survey data assembled first-hand at the processing plants, to determine what structural and operational areas are most vulnerable. Beginning with such weak links, practicable hardening measures are then evolved. Consideration of available target-analysis data and the economics of hardening governs implementation of a comprehensive plant protection program. Because of the present general apathy toward civil-defense activity, positive incentives for industry, involving active participation by the federal government, perhaps tax writeoffs, appear in order. Specific plant-study material is included, together with sample calculations for assessing vulnerability at industrial installations. Representative data are included for plants engaged in flour milling, yeast culture, cane sugar refining, edible oil processing, citrus juice processing, sardine packing, and the manufacture of metal or waxed-carton food containers. (C.H.)

11306 (HW-65182RD) ELECTRICAL SEAL TESTS. Final Report. H. F. Jensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 4, 1965. Contract AT(45-1)-1350. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Tests were made to determine leakage rates at 5 and 15 psi when the Rockbestos NPR control cable was filled with various silicones as sealants. Similar tests were made on conduits sealed with Eureka foam and silicones, and on single wires sealed with solder. (D.L.C.)

11307 (NAA-SR-9889) EXPERIMENTAL STUDY OF INELASTIC STRAINS IN HOLLOW CYLINDER OF 6061 ALUMINUM SUBJECTED TO A BAND OF INTERNAL PRESSURE. Vincent W. Anderson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT(11-1)-Gen-8. 42p. Dep.; $2.00(OTS).

Equipment was developed to subject a hollow cylindrical specimen to a limited band of internal pressure in order to put the cylinder material in a plastic state of strain. Strains on the outside surface of the cylinder were measured by electric strain gages mounted circumferentially and longitudinally on the cylinder. The geographic distribution of strains in the region of the band of pressure was observed visually by molding a birefringent plastic which was bonded to the test cylinder. Internal cylinder pressures up to 640 psi were produced, developing strains up to approximately 2% circumferential expansion of the cylinder. The magnitudes and distribution of inelastic strains on the exterior surface of the test cylinder were determined. An analysis of strains within the region of the band of internal pressure revealed that peak longitudinal as well as peak circumferential strains on the exterior surface of the cylinder occurred at the midwidth region of the band pressure. However, at a distance of approximately one-third the band width on either side of the band of pressure, the longitudinal strains were compressive rather than tensile, and were slightly larger than at the centerline of the band of pressure. (auth)

11308 (NAA-SR-Memo-10591) RESPONSE OF A ONE DEGREE OF FREEDOM VIBRATION SYSTEM TO VARIOUS SHOCK IMPULSES. D. Chin (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 21, 1964. Contract AT-11-1-GEN-8. 21p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A single degree of freedom system was analyzed for shock pulses applied to the supporting structure. The shock inputs were prescribed in terms of accelerations. The three shock pulses considered were the square wave, sine wave, and isosceles triangular wave. Response spectra were determined for each of the respective shocks, and curves were plotted showing the amplification factor versus the frequency ratio w/w_f. The amplification factor is defined as the ratio of the maximum acceleration response to the maximum acceleration input. These curves can be used for design purposes if the frequency ratio is known. However, if the frequency ratio is unknown, the maximum acceleration response is 2.00 for square wave, 1.76 for sine wave, and 1.52 for isosceles triangular wave. (auth)

11309 (ORNL-3624) NBC—AN IBM 7090 COMPUTER PROGRAM FOR SOLVING THERMOELASTIC PROBLEMS. F. J. Witt (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 54p. Dep.; $3.00(OTS).

A numerical means was developed for calculating stresses in bodies with the use of either a plane-strain or a plane-stress model. The particular problem considered is the evaluation of thermal or irradiation-induced stresses for arbitrary temperature or irradiation-exposure distributions. A computer program, NBC, is described that may be used to solve the two-dimensional nonhomogeneous biharmonic equation pertinent to the analysis of simply connected and multiply connected regions. The material may be isotropic or it may only exhibit isotropy in the plane of the cross section. The bi-

harmonic equation and related boundary conditions are derived and an example is presented. Complete instructions for using the program are given. (auth)

11310 (SC-DC-64-1433) THERMAL DETECTION METHOD FOR EXTREME ENVIRONMENTS. Quarterly Progress Report No. 1, April 1–June 30, 1964. George Kalon (Marquardt Corp., Van Nuys, Calif.). For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The objective of this program is to develop a method for detecting the thermal energy of extreme environments resulting from aborted missile and aerospace rocket launchings. Diffusion is a major mechanism under consideration. Study to date indicates the sensitivity of the diffusion approach will be substantially increased by the use of radioactive isotopic diffusion elements in conjunction with microautoradiographic detection techniques. Nickel-63 appears to be the best isotope for this method. The evaluation of thermal energy by weight loss measurements with graphite or similarly degradable materials have been dropped from further consideration. (D.L.C.)

11311 (SWRI-1228-50) FUNDAMENTAL INVESTIGATION OF LIQUID-METAL LUBRICATED JOURNAL BEARINGS. Quarterly Technical Report No. 3. R. A. Burton, H. J. Carper, Y. C. Hsu, and P. A. Hunter (Southwest Research Inst., San Antonio). Jan. 14, 1965. Contract AT-(11-1)-1228. 60p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A method was developed for determining the friction coefficient at the wall. The simple expression for the turbulent wall-law velocity profile was found to give a good fit of the empirical velocity profile data. Pressure profiles for the full bearing in the large-scale turbulence apparatus were obtained at three Reynolds numbers. Skewed flows were produced by an obstruction in the bearing film, and pressure and profile data are given. Improvements and corrections are given for the derivations for analysis of turbulent-film bearings, and the analytical techniques were extended to pads without end leakage and with inertial effects. (D.L.C.)

11312 (TID-21444) TRANSLATIONAL EFFECTS OF BLAST WAVES. A Review of Past Work and Suggestions for Future Experiments with 500-Ton High-Explosive Shot. Technical Progress Report. I. G. Bowen, D. R. Richmond, and C. S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Mar. 11, 1963. Contract DA-49-146-XZ-055. 62p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A discussion is presented of the phenomena considered in the theoretical study of the behavior of secondary missiles. The experimental techniques used in the field studies are described, and some of the experimental results are compared with predictions. A few proposed experiments are presented for the 500-ton shot to be detonated in 1964 at the Suffield Experimental Station. (D.L.C.)

11313 (TID-21557) AN ANALYSIS OF THE TRAILING-EDGE EFFECT IN SLIDER AND PARTIAL-ARC GAS-LUBRICATED BEARINGS. Interim Report. H. G. Elrod, Jr. and J. T. McCabe (Franklin Inst. Labs. for Research and Development, Philadelphia). Dec. 1964. Contracts [AT(30-1)-1484] and Nonr-2342(00). 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An investigation was conducted of the behavior of the pressure distribution within partial-arc and slider bearings under conditions of high-speed operation. It was shown that: In high-speed operation most of the bearing simply acts as a viscous pump, with its gas output expanding to ambient through a short region near the trailing edge. The point of maximum pressure is a point of transition. Upstream of this point the pressure deviates from the infinite lambda value ($p = p_a h_1/h$) by an amount of order (1/Λ). Downstream of this point the pressure drops rapidly to ambient pressure through a distance of order (1/Λ). A procedure is given for finding numerical values for the dimensionless pressure function PH/K. Values obtained from the present asymptotic analysis agree well with those of Gross and with those of McCabe. (auth)

11314 (WCAP-3269-27) FRICTION-SPEED CHARACTERISTICS OF THRUST BEARINGS FOR REACTOR COOLANT PUMPS. John Boyd and A. A. Raimondi (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Oct. 1963. Contract AT(30-1)-3269. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A test program was formulated to determine friction-speed characteristics of Kingsbury-type water-lubricated thrust bearings in low speed ranges. The purpose of the investigations was to obtain data correlations to aid in predicting the existence of a hydrodynamic film (and adequate bearing lubrication) when a de-energized pump is subjected to reverse flow in a loop without check valves. Tests of model bearing pads were conducted in a specially constructed apparatus under varying conditions of water temperature, bearing load, and speed. Results of the tests indicated a low probability of prolonged operation of a bearing in a speed range in which a full hydrodynamic film is not established. (auth)

11315 MANNED SPACE STATION ORBITING IN THE VAN ALLEN BELT. J. J. Gilvarry and D. H. Sowle (General Dynamics/Astronautics, San Diego, Calif.). J. Spacecraft Rockets, 1: 127-8(Jan.-Feb. 1964).

It is shown that, in the light of recent results, the micrometeoroid risk can be dissipated by centering design criteria on radiation protection and external heat rejection. Estimates of mean times for penetration and probabilities of no penetration of 1 cm of Al in one yr are given. Data from Explorer XVI, the Echo balloon, and Mercury capsules are discussed in confirmation of the lack of need of a meteoroid bumper; the only contrary evidence is in the case of Explorer III. (M.J.T.)

11316 SUMMARY AND RESULTS OF A STUDY FOR E.N.E.A. ON A 53,000 DWT-CLASS NUCLEAR TANKER UNDERTAKEN BY THE DUTCH INTERNATIONAL TEAM. M. Muysken (Reactor Centrum Nederland, The Hague) and M. C. van Veen. p.77-105 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The results of a study on a 53,000-DWT nuclear tanker using either a PWR or a saturated water reactor are summarized. The principal characteristics of the project are outlined. The hull and its fittings, reactor installation, propulsion plant, lay-out of electric generating plant, and economic aspects are considered. (J.S.R.)

11317 PREPROJECT OF A 20,000-DWT NUCLEAR POWERED BULK CARRIER. E. Olderin (Stal-Laval Turbine Co., Stockholm), J. Wilhelmsen, and G. Nilson. p.107-47 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The preliminary design of a 20,000-DWT nuclear powered bulk carrier powered by an indirect cycle boiling water reactor is presented. The ship characteristics, reactor plant, reactor dynamics, main propulsion machinery, and costs are described. (J.S.R.)

11318 STUDY OF A NUCLEAR OCEANOGRAPHIC LINER FOR THE O.C.D.E. NUCLEAR ENERGY AGENCY. A. A. Normand (Chantiers et Ateliers Augustin Normand, Le Havre, France). p.149-59 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In French)

The characteristics required in a nuclear oceanographic liner are briefly described. The purpose of such a liner for both oceanographic studies and investigation of the operation and maintenance of a nuclear ship is indicated. (J.S.R.)

11319 ELECTRIC CONDUCTIVITY IN EQUILIBRIUM AND NONEQUILIBRIUM IN A SEEDED GAS. E. Labois and A. Lemaire (Commissariat à l'Énergie Atomique, Saclay, France). 12p. (CONF-640701-98). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The validity of the theory concerning the electric conductivity of a rare gas seeded by an alkaline was tested by measuring the conductivity at equilibrium and non-equilibrium of the Ar–Cs fluid in the absence of a magnetic field with almost zero flow velocity, constant temperature at

1790°K, constant total pressure of the fluid at atmospheric pressure, and variable partial pressure of Cs. The shape of the variation of resistivity at non-equilibrium was found as a function of the variables of current density and seeding rate. The theory correctly described the phenomena. The cross sections for the collision of Ar and Cs were deduced, along with the value for the coefficient of electron-ion recombination. (J.S.R.)

11320 CONDUCTIVITY OF SEEDED COMBUSTION GAS. F. Rostas (Compagnie Générale d'Electricité, Marcoussis, France). 9p. (CONF-640701-92). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The electric conductivity of mixtures of oxygenated kerosene seeded with potassium at pressures from 0.1 to 1 atm was calculated. Although there were uncertainties in the value of the potential of attachment of the hydroxyl radical and the collision cross section, an analytical expression of the conductivity valid to almost 30% between 2000 and 3200°K was derived: $\sigma = [T/2200]^{13} \times p^{-[0.5+(3000-T)/1000 \times 0.25]}$, with T in °K and p in atmospheres. (J.S.R.)

11321 MEASUREMENT OF THE ELECTRIC CONDUCTIVITY OF SEEDED COMBUSTION GAS. R. Devime, H. Lecroart, J. Poncelet, A. Pozwolski, and A. Quéraud (Commissariat à l'Énergie Atomique et de l'Institut Francais du Petrole, France). 11p. (CONF-640701-93). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Two methods for the measurement of the electric conductivity of combustion gases seeded with 0.8 mole % K are described: the oscillating circuit method and the probe method. The results obtained with the two methods were compared. The probe method was then used for a laboratory-scale study of the measurement of the electric conductivity. The conductivity of butane–air and butane–air mixtures enriched in oxygen could be determined at seedlings $0.4\% < \alpha < 1.3\%$. Electrolytic pulverizations gave higher seeding rates than pneumatic pulverization. (J.S.R.)

Applications of Nuclear Explosions

11322 (UCRL-13104) NUCLEAR MINING FEASIBILITY STUDY. Final Report. (Anaconda Co., Butte, Mont.). [nd]. For Univ. of California, Lawrence Radiation Lab., Livermore. Contract W-7405-eng-48. 72p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A study was made of the possible economic advantages of using nuclear devices to strip an ore body or to break low-grade ore deposits. Costs of mining a copper ore body by conventional open pit and block cave mining methods are estimated and compared with expected nuclear costs. The feasibility of nuclear stripping of a submarginal copper ore deposit of 0.9% Cu grade and a stripping ratio of 11 : 1 was also studied. (D.L.C.)

Facilities and Equipment

11323 (ARL-64-211) CONTINUED STUDIES ON ELECTROMAGNETIC MEANS OF ADDING HEAT AND KINETIC ENERGY TO A GAS. Eugene E. Covert, Laurence R. Boedeker, and Charles W. Haldeman (Massachusetts Inst. of Tech., Cambridge). Sept. 10, 1964. Contract AF33(657)-7975. 137p. OTS.

Electromagnetic means of adding heat and kinetic energy to a flowing gas stream are studied. Included are discussions of: the nonequilibrium r-f plasma source; design considerations for accelerator coils for the traveling wave pump plasma accelerator; the effects of using magnetic core material in the accelerator coils; numerical results for the one-dimensional flow in the traveling wave pump for various modes of operation; and methods of instrumentation employed to measure plasma properties. (auth)

11324 (BDX-613-3) FUNDAMENTALS OF HYDROGEN THYRATRONS. S. J. Catalano (Kansas. Univ., Lawrence). June 1960. Contract [AT(29-1)-913]. 143p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Following studies of the fundamental aspects of electric conduction in gases and of hydrogen thyratrons, an outline is given of the characteristics of the Type 1258 Miniature Hydrogen Thyratron. (T.F.H.)

11325 (HW-82153(Rev.1)) DESIGN CRITERIA FOR RADIOSURGERY FACILITY, BUILDING NO. 748. Edgar F Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 20, 1964. Contract AT(45-1)-1350. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Design criteria are outlined for a radiosurgery facility to provide emergency surgical treatment and follow-up care for patients having embedded radioactive materials emitting up to 500 R/hr of γ radiation. Emphasis is placed on traffic patterns of both personnel and equipment for the control of radioactive contamination. (C.H.)

11326 (HWS-6574(Rev.1)) SPECIFICATION FOR CONFINEMENT SEALS. 105-N and 109-N Buildings, Project CAI-816. H. F. Jensen and G. E. Wade (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 17, 1961. Rev. 1: Apr. 19, 1961. Contract AT(45-1)-1350. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Includes Appendices A through D.

The specification covers the purchasing, forming, mixing, placing, curing, and testing the confinement seals on all joints, openings, or penetrations into Zone I of 105-N and 109-N and Zone II of 105-N buildings. The seals will serve to contain the fission products in the event of a nuclear incident. Materials and workmanship are discussed. (D.L.C.)

11327 (NDL-TM-15) A POINT-SOURCE CIRCULATION SYSTEM FOR SIMULATING FALLOUT GAMMA RADIATION. Ralph E. Rexroad, Murray A. Schmoke, and Michael J. Schumchyk (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Dec. 1964. 22p.

The point-source circulation system has proved to be an efficient method for simulating fallout gamma radiation for shielding studies involving combat vehicles and structures. It is particularly effective for shielding studies that involve irregular geometries where use of symmetry techniques to reduce the area over which source simulation is required is limited. Additionally, since the effective radiation resembles a line or area source, local effects in the object under study, such as those caused by apertures or irregular thickness of material, are averaged out in a manner similar to those occurring under actual fallout conditions. (auth)

11328 (NP-14547) MESSUNGEN AN EINEM ZYKLON VOM FALLTYP FUR ZWANGSUMLAUF-SIEDEWASSER-REAKTOREN. BERICHT NR. 199. (Measurements on a Precipitation-Type Cyclone Separator for Pressure-Loop Boiling Water Reactors. Report No. 199). Vollradt (Allgemeine Elektrizitätsgesellschaft. Forschungsinstitut, Frankurt am Main). Apr. 10, 1964. 32p. Dep.(mn).

Within the framework of development of high-power boiling water reactors, precipitation-type cyclone separators (centrifugal downcomer separators) for steam–water separation were studied. These cyclone separators are to be connected in the coolant circuit within the pressure vessel and should provide for as large as possible reduction of the carryunder in the precipitation area. The results obtained in the forced test station with air–water mixtures were reported. The degree of separation and pressure losses were measured as functions of the water input, volume through-put ratios, water state above cyclone lower edge, and water temperature. (J.S.R.)

11329 (NP-14553) JAHRESBERICHT ÜBER DIE AM UMLAUFVERSUCHSSTAND DURCHGEFÜHRTEN ARBEITEN (1963). (Annual Report on Work Conducted with the Loop Test Facility (1963)). (Allgemeine Elektrizitätsgesellshaft, Frankfurt am Main). Jan. 22, 1964. 6p. Dep.(mn).

The planning and construction of the loop test facility

to study the flow and output behavior in the channel of a marine boiling water reactor was reported. The thermodynamic lay-out and the establishment of the principal dimensions, construction of the mechanical parts of the facility, planning of the measuring and control parts, and planning of the electrotechnical part of the installation are reported as the work performed in 1963. The facility was put in commission and the preparation and the delivery of the individual components were supervised. (J.S.R.)

11330 (SGAE-IB/IA-4/1964) EINE RADIOMETRISCHE DISTANZSTEUERUNGSVORRICHTUNG FUR KRANANLAGEN. (A Radiometric Distance-Controlling Device for Crane Installations). K. E. Duftschmid, W. Attwenger, and J. Steidl (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf). [1964]. 20p. Dep.(mn).

A safety installation is described that was developed for remote measuring and control of several hanging cranes traveling in a common path. It consists of a collimated gamma radiation source and scintillation measurement probes that are mounted on two opposite sites by two adjacent cranes. The scintillation probe is connected with a special counting rate device aligned for special operational safety with five threshold stages, which release optical long-distance readings, a velocity forced control, and auxiliary acoustical alarm signals when the least permitted distance is reached. At a total reading time of 0.3 sec and an accuracy of the remote measurement of more than ±5%, the instrument represents an efficient and reliable safety system that can prevent a dangerous approach of the cranes to each other. With suitable installation, sufficient shielding, and strict collimation of the radiation sources, radiation injury to personnel can be avoided. (tr-auth)

11331 (ORNL-tr-409) VERTICAL LATHE AO4. Jan Korenek. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 48-61(1964). 24p. Dep.(mn); $2.60(fs), $0.92(mf) JCL.

The vertical lathe AO4 was developed for machining both the pressure vessel sections and the vessel itself for the Czechoslovakian nuclear power plant at Bohunice. A technical description of the machine is given, and work parameters are tabulated. The costs are compared with those of the vertical lathe SK 125. (D.L.C.)

11332 CONSTRUCTION OF A ^{60}Co-γ-RADIATION INSTALLATION. H. Kroenert and G. O. Schenck (Max-Planck-Institut für Kohlenforschung, Meulheim, Ger.). Chem. Ing. Tech., 35: 641-7(Sept. 1963). (In German)

The location, details, radiation shielding, safety precautions, and technical equipments of a ^{60}Co source installed in a bunker are described. The installation was designed for a max of 50000 C to be used for small scale radiation studies. The bunker is provided with an ample power supply and adequate ventilation. The system is designed to provide slightly decreased pressure within the room where the source is installed. The air is recirculated 8 times/hr. The ventilation is closed down when a fire alarm is triggered, also bringing a battery of CO_2 extinguishers into operation. A television camera is provided in order to observe radiation studies remotely. In order to reduce darkening of the objective lens by the radiation as much as possible, the camera is rotated when not in use to a portion of the room where the radiation field is considerably lower. The isodose curves are completely symmetrical in the region of the source, and would amount to a total lethal dose of 700 Rad to a human exposed for one hr at a distance of 3 m. So far the installation has been used for more than 7000 radiation hours without any down time. The advantages of this type of source to study radiochemical processes are that the spectrums and the penetrability of the radiation emitted is constant. The radiation flux is almost constant, decreasing by only 0.1% in two days. The dose is constant over a large volume within the source area. Radiochemical reactions can be studied at elevated pressures in autoclaves, in closed systems at very low temperatures, or in thick layers. (BBB)

11333 FRAMING CAMERA, MODEL X-9 (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-849)

Eleven drawings are included. The continuous writing, framing camera (10 in. EF/20) has a rotating mirror of three faces to form a prismatic unit with an equilateral triangle cross section. The H-17 steel mirror is 3.356 in. at the base, 2.906 in. high, and 2 in. deep. Both fast and slow speed shutters are included. (P.C.H.)

11334 METALLOGRAPHY EXAMINATION AND PREPARATION FACILITY, HIGH LEVEL CAVES (Engineering Materials). (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). (CAPE-1164)

Twenty-three drawings are included. The remote Metallography Facility is capable of preparing and examining 200 high quality specimens per month. The facility is installed in five general-purpose hot cells. Each major preparation step is performed in a separate cell: cutting, mounting and grinding, polishing, etching, and examination. Each cell is equipped with a pair of Model 8 master-slave manipulators. All equipment is designed on a modular basis to permit flexibility in arranging the equipment for maximum utilization. (P.C.H.)

11335 FILTER INSTALLATION STANDARD (Engineering Materials). (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). (CAPE-1149)

One drawing is included. The welded, angle iron filter frame is used with chemical warfare, high efficiency particulate air filters. The filters are 24 × 24 × 11½ in. These are supported, positioned, and held in the frame by heavy stud bolts, which make it easy to service the filters. (P.C.H.)

11336 DESIGN OF MINIMUM WALL-THICKNESS MULTIREGION HIGH-PRESSURE CYLINDERS. Roy L. Huddleston (Union Carbide Corp., Oak Ridge, Tenn.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/PT-8, 13p, $1.00. (CONF-763-17)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The wall thickness of multiregion, thick-walled cylinder assemblies subjected to internal pressure is theoretically minimized by combining the Lame equations for the stress distribution in thick-walled cylinders with the von Mises yield theory. Results of the minimization analysis are presented in the form of plots of nondimensional radius and pressure parameters for the cases of 1, 2, 3, 4, and 5 regions. The infinite-region case is also shown as an envelope or limiting curve. A diagram to aid in the choice of the optimum number of regions for use in an arbitrary design application is also given. The design of a general thick-walled cylinder assembly can then be optimized by selecting appropriate radii and pressure ratios from the curves. (auth)

11337 PERIPHERAL-COMPRESSOR PERFORMANCE ON GASES WITH MOLECULAR WEIGHTS OF 4 TO 400. P. S. Cates (Oak Ridge Gaseous Diffusion Plant, Tenn.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/FE-25, 12p, $1.00. (CONF-763-16)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Performance characteristics of a peripheral compressor tested on a large variety of gases over a wide range of speeds are presented. Gases tested ranged in molecular weights from 4 to 400. General characteristics are presented in Mach numbers extending well into the compressible realm of operation. Compressor performance curves show the effects of channel geometry, impeller-to-casing clearance, and nozzle design. A brief comparison of six peripheral compressors tested by independent organizations was made. (P.C.H.)

11338 SUPERCONDUCTIVE BEARINGS. Theodor Buchhold (General Electric Co., Schenectady, N. Y.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/PID-9, 5p. $1.00. (CONF-763-8)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Two superconductive magnetic-bearing principles are compared. The first principle keeps the total flux constant as current changes with a changing bearing gap. The leakage flux of the coil circuit limits the bearing stiffness. The second principle keeps the total ampere-turns constant when an additional fixed reluctance is inserted in the magnetic path. The bearing stiffness, which can be made large by using small gaps easily incorporated into the bearing design, is not influenced by coil leakage. (auth)

11339 A DUAL-ELEMENT TRANSDUCER FOR MEASURING HIGH GAS-STREAM TEMPERATURES. W. H. Giedt and J. T. Chambers (Univ of California, Berkeley). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-45, 8p. $1.00. (CONF-763-4)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An experimental evaluation of a dual-element transducer for measuring gas-stream temperatures is described. Temperatures are inferred from simultaneous temperature-time measurements of two elements of identical geometry but unequal thermal capacity. The major effort was devoted to measurements in medium-temperature streams to prove the feasibility of the method. The accuracy of the results was within ±6% for measurements from 1950 to 2250°F, which was the best experimental accuracy predicted by an earlier analysis of the concept. A limited number of measurements was made in an oxyacetylene flame. The indicated flame temperatures were 4700 and 4789°F, which agree within 5% with measurements made by sodium-line-reversal techniques for equivalent combustion conditions. A gas-stream temperature profile measurement is also presented. (auth)

11340 DETACHABLE ELECTRIC CONNECTING DEVICE. Jean Liermann (to Commissariat a l'Energie Atomique). British Patent 972,928. Oct. 21, 1964. Priority date July 16, 1962, France.

The connecting device described consists of an assembly secured to the wall of a nuclear reactor channel and a tubular detachable assembly disposed in the same channel. The assembly secured to the wall has at least one fixed contact element of which the inner contact face has a diameter substantially the same as the remainder of the channel. The detachable assembly is of small thickness in relation to the radius of the channel and includes an inner member and an outer member relatively movable along the axis of the channel. The outer member has at least one contact finger so mounted that it is retracted when the inner member is in one position and extended when the inner member is in a second position. In its extended position the finger contacts the assembly secured to the wall. The design may be varied to fit a particular type reactor channel, but the small radial dimensions of the movable assembly insure a small loss in pressure of the cooling fluid. (A.G.W.)

11341 REMOTE CONTROL APPARATUS FOR ACTING UPON DANGEROUS MATERIAL. Jean Claude Eude, Claude Piron, Jean Savouyard, and Jean Vertut (to Commissariat a l'Energie Atomique). British Patent 973,101. Oct. 21, 1964. Priority date Feb. 16, 1960, France.

The apparatus described consists of a manipulation head and a support upon which the head is mounted. The head includes an arm, a forearm, and a pincer, and is constructed and arranged for unlimited rotation of the arm, for elbow movement of the forearm with respect to the arm, for unlimited rotation of the pincer with respect to the forearm, and for closure of the pincer. Kinematic linkages transmitting the movements to the head are driven by four motors, one for each movement, mounted at the maximum practicable distance from the pincer. Means are provided for changing and/or repairing the motors. Various types of supports, which provide supplementary movements, are described. (A.G.W.)

11342 IMPROVEMENTS IN OR RELATING TO VALVE OPERATING MECHANISMS. Didier Costes (to Commissariat a l'Energie Atomique). British Patent 973,176. Oct. 21, 1964. Priority date Aug. 18, 1961, France.

A centralized operating mechanism is described for the selective individual control of a plurality of adjustable valves located in a vessel and arranged on a cylinder of revolution. Each valve controls communication between the vessel and a pipe and includes an adjustment member rotatable around a line radial to the axis of the cylinder. A shaft, slidably and rotatably arranged along the axis of the cylinder, is adapted to engage any one of the valve adjustment members and cause screwing or unscrewing of the member. The shaft extends outside the vessel and through a biological protection screen, if needed, to a remote operator means. A lighting device and an endoscope may be arranged in the shaft to allow the operator to view the valve being adjusted. Each valve is provided with a resilient locking device for locking the adjustment member when it is not engaged by the shaft. (A.G.W.)

11343 DEVICE FOR DETECTING THE POSITION OF A REFLECTING SURFACE. Jean Passe (to Commissariat a l'Energie Atomique). British Patent 973,466. Oct. 28, 1964. Priority date Feb. 7, 1962, France.

An optical device for detecting from a distance variations of the level of a reflecting surface about a predetermined position is described. Light beams of a predetermined frequency are emitted alternately from the two parts of a double light source. An optical device directs the beams onto the reflecting surface and directs the reflected beams to a sensing device through a slit in a screen when the reflecting surface is in a predetermined position with respect to the source. The sensing device used is selectively sensitive to light modulation of the predetermined frequency, and the slit is so located that the screen attenuates one of the beams upon departure of the reflecting surface from the predetermined position. The displacement is then detected by the sensing device. The device is particularly applicable to the determination and/or control of the level of the free surface of a liquid. (A.G.W.)

Heat Transfer and Fluid Flow

Refer also to abstracts 12137 and 12738.

11344 (ACNP-64029) INVESTIGATION OF VAPOR VOLUME FRACTION AND SLIP VELOCITY UNDER THE EURATOM PROGRAM. Final Report. Kenneth F. Neusen, Mark Healy, Winfred A. Bezella, and Glenn J. Kangas (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Nov. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT (11-1)-1272. 96p. (EURAEC-1291). Dep.(mn); $3.00(cy), 2(mn) OTS.

A series of experiments, designed to measure vapor volume fractions in the vertical flow of steam–water mixtures in a large unheated duct (2.9-inch ID pipe), was performed over a wide range of flow conditions. The scope of the experiments covered a range of superficial liquid velocity from zero to twenty feet per second. System pressures for the experiments were set at 600, 1000, and 1500 psi. The principal measuring device was a gamma ray attenuation system which determined the vapor volume fractions by a traversing technique. Traverses were made at three different axial locations corresponding to L/D values of 8.3, 12.4, and 16.5. At low flows, vapor volume fractions were also measured by the static pressure differences in the duct as indicated by deflections of a high pressure manometer. Average vapor volume fractions were correlated using the liquid and vapor superficial velocities and system pressure. Below superficial liquid velocities of 2.5 fps, the manometer technique gave results which were within 20 per cent of the true average voids. Phase distributions indicated by the individual traverses were analyzed and compared to two simple phase distribution models. An entrance effect was noted which appeared to be more prevalent at high velocities. (auth)

11345 (COO-774-5) FLUID-SOLID HEAT TRANSFER STUDY. Final Report, May 1, 1959–September 30, 1964.

Robert S. Brodkey (Ohio State Univ. Research Foundation, Columbus). Oct. 1964. Contract AT(11-1)-774. 51p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A project directed toward obtaining heat transfer coefficients for both packed and fluidized bed systems by a frequency response method and toward obtaining direct measurements of the temperature of the solid particles within the fluidized bed is described. The feasibility of the use of a frequency response method for the determination of the particle-to-gas heat transfer in packed and fluidized bed systems was demonstrated. For packed beds there is also the possibility of determining the axial diffusion or gas back-mixing and the effective thermal conductivity of the bed from the same experiments. To this end, an approximate solution for small particles and a general parametric solution of the controlling equations was formulated and preliminary results from the study cited. Comparisons of the theoretical results with experimental runs showed good agreement, and in effect was a determination of the parameters controlling the heat transfer in the system (particle-to-gas transfer, back-mixing, and conduction). The general parametric study can be used in guiding other frequency response experiments involving some or all of these mechanisms. An understanding of the transfer processes in packed and fluidized beds was not confirmed. (auth)

11346 (COO-926-33) [CRITICAL FLOW OF LIQUID METALS]. H. S. Isbin (Minnesota. Univ., Minneapolis. Inst. of Tech.). Jan. 15, 1965. Contract AT(11-1)-926. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Graphs are given which show the application of the Moody model for estimating the critical (two-phase) flow rates of the liquid metals Cs, Na, K, Li, Rb, and Hg. The Moody and Fauske models are discussed, and equations are given. (D.L.C.)

11347 (EUR-2193.e) FUNDAMENTAL STUDIES OF FLUID FLOW AND HEAT TRANSFER IN FUEL ELEMENT GEOMETRIES. I. ANALYSIS OF FLUID FLOW AND HEAT TRANSFER IN TRIANGULAR ARRAY OF PARALLEL HEAT GENERATING RODS. R. Nijsing, I. Gargantini, and W. Eifler (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy). 1964. 104p. Dep.(mn).

The study deals with theoretical considerations on fluid flow and heat transfer for axial turbulent flow in non-circular channels. An analysis is proposed which may be used to evaluate flow resistance and mean heat transfer characteristics associated with such geometries, and to establish the distribution around the channel periphery of several local hydrodynamic and thermal parameters. These parameters comprise local coolant velocities, local shear stresses, local coolant temperatures, and local heat transfer coefficients. The system for which calculations have been carried out is a triangular array of parallel heat generating rods. The effect has been established which rod spacing, Reynolds number, and Prandtl number have on fluid flow and heat transfer for this geometrical configuration. Two heat transfer boundary conditions have been considered: that of uniform heat flux around the rod periphery and that of uniform surface temperature around the rod periphery. Predictions of the analysis for conditions of laminar flow well agree with results obtained in an exact manner. (auth)

11348 (EURAEC-1219) STABILITY TESTS FOR BOILING WATER-REACTORS. Quarterly Report No. 2, July 1–September 30, 1964. (Allgemeine Elektrizitats-gesellschaft, Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. Contract 020-64-4-TEED. 40p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The theoretical experiments aimed at improving the regulation of the operating pressure and subcooling were completed and work virtually finished on the modifications to the test-rig necessitated by the alterations to the regulation system. A purification circuit is being installed in order to ensure constantly pure water conditions. A flow-rate modulator was designed for regulating the flow-rate at the heating section inlet. It forms part of a control system by means of which the flow-rate can be regulated at will or allowed to oscillate at frequencies of up to 10 cps. Orders were placed for all the components of this control circuit. Detailed experiments and work were carried out on the instrumentation and data-processing. After a few difficulties were overcome, fault-free measuring signals for the power, throughput, pressure drop, and subcooling were obtained. Work was concluded on the equipment for determining the density of the two-phase mixture in the heating section by means of gamma-radiation, and a start was made on the installation of the measuring apparatus in the test-rig. Initial tests were carried out on the test-rig to check the method for measuring the frequency, which involves the use of an analog computer. The basic principles of the measuring system used are given. The transfer functions for the theoretical determination of the directly measurable local steam void fraction were elaborated on the basis of the model, account also being taken of the influence of the heat stored in the wall of the coolant channel. (auth)

11349 (EURAEC-1224) INVESTIGATION OF BURN-OUT IN THE CASE OF BOILING WATER. Quarterly Report No. 12, July 1–September 30, 1964. H. H. Agena and D. Henkel (Maschinenfabrik Augsburg-Nurnberg A. G., Nuremberg). Oct. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The series of tests with a tube of 5 mm inside diameter and 578 mm heated length at pressures of approx. 100 atm over were concluded. The interpretation of the experimental results yielded burnouts which were lower than that obtained by applying various burnout equations. This is to be ascribed to instabilities in the power volume. In tests performed subsequently, it was possible to establish that this was caused by instabilities of the steam cushion between test tube and pressure tube. Two burnout detector systems were tested on an atmospheric experimental apparatus. Both systems utilized operated with a degree of reliability of approx. 90%. (auth)

11350 (NASA-TN-D-2626) EXPERIMENTAL STUDY OF SUBCOOLED NUCLEATE BOILING OF WATER FLOWING IN ¼-INCH-DIAMETER TUBES AT LOW PRESSURES. Frank A. Jeglic, James R. Stone, and Vernon H. Gray (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). $2.00(OTS).

Nucleate boiling of subcooled water flowing vertically upward through ¼-inch electrically heated tubes was experimentally investigated over the following range of conditions: exit pressure, 17 to 100 pounds per square inch absolute; flow rate, 0.52×10^6 to 3.45×10^6 pounds per hour per square foot; heat flux, up to 3.0×10^6 Btu per hour per square foot; wall temperature, up to 520°F; liquid subcooling, up to 180°F; and tube length, 25, 50, and 100 diameters. Measurements of local heat flux, axial distribution of tube wall temperature, tube inlet and exit fluid temperatures and pressures, and inlet pressure fluctuations were obtained. Plots of heat flux, pressure drop, and pressure fluctuations are presented as functions of exit fluid temperature, wall temperature, and saturation temperature. Wall temperatures were nearly independent of fluid bulk temperature and mass flow for the fully developed nucleate boiling range investigated. Pressure drops in excess of 18 times the isothermal liquid-phase pressure drop were measured. High-frequency large-amplitude pressure fluctuations, believed to be caused by bubble collapse, were recorded. (auth)

11351 (UCRL-7960) A PROCEDURE FOR THE NUMERICAL TREATMENT OF GENERALIZED HEAT-TRANSFER PROBLEMS. Michael D. Mintz (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 1964. Contract W-7405-eng-48. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A general procedure is presented for the numerical analysis of practical heat transfer problems of virtually

any degree of complexity. The processes of conduction, convection, grey and translucent body radiation, internal heat generation, and transient heat energy storage and mass transfer are considered. Material properties are assumed to be arbitrary functions of temperature. It is intended that the actual numerical calculations will be performed by a digital computer with suitable subroutines for matrix inversion. The simplicity of expressing these methods in the form of a FORTRAN digital computer code is demonstrated by a straight-forward sample problem: the analyses of a rotating spherical shell in the field of a plane wave radiation energy flux. (auth)

11352 (Y-JA-18) COOLING TOWER MAINTENANCE. J. R. DeMonbrun (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). Jan. 13, 1965. Contract W-7405-eng-26. 29p. Dep.(mn); $2.00(cy), 1(mn) OTS.

An account is given of experience in the maintenance of cooling towers. The information presented was developed from field and laboratory tests. (D.L.C.)

11353 SOME IDEAS ABOUT THE MECHANISM CAUSING TWO-PHASE CRITICAL FLOW. Hans K. Fauske (Argonne National Lab., Ill.). Appl. Sci. Res., Sect. A, 13: 149-60(1964).

While the theory concerning critical discharges of single-phase flow is well known, the opposite is true for two-phase mixtures. The question still remains of whether critical flow occurs for two-phase flow with the same implications as for single-phase flow. A theoretical analysis, supported by experimental data, indicates that the implications for single-phase and two-phase critical flow differ significantly. While single-phase flow is restricted by so-called sonic choking, the extra freedom available in a two-phase flow system, the slip ratio, restricts the maximum flow in the latter. Two-phase critical flow is achieved when the slip ratio takes on a value such that the rate of momentum gain by convection per unit volume becomes identical in each fluid phase. (auth)

11354 CONTROL OF THE INTERFACE AND DETECTION OF ITS OSCILLATION IN PULSED COLUMNS. G. Bodini, A. Facchini, A. Novelli, and A. Rimini. Automazione Strumentazione, 12: 420-4(Oct. 1964). (In Italian)

Oscillations of the interface formed during the expansion of a pulsed column affect the functioning of the pulse column both in its extractive characteristics and in its fluid dynamics. The conditions of unstable operations and of flooding are shown by a displacement of the position around which the interface oscillates. The construction and performance of an electronic device that makes possible the continuous detection of such operation and that, consequently, acts on the flow of the two liquids feeding the column is described. (J.S.R.)

11355 A CONSIDERATION ON THE HEAT TRANSFER IN LIQUID METAL. Shigebumi Aoki (Tokyo Inst. of Tech.). Bull. Tokyo Inst. of Tech., Ser. B, No. 54, 63-73(Sept. 1963).

Liquid metal has excellent characteristics as a coolant for nuclear reactors, especially for a fast reactor. The effect of eddy diffusivity in the flow is discussed and an equation for the ratio of eddy diffusivities, which is a function of Prandtl number and Reynolds number is introduced. By applying this value to the modified Martinelli-Lyon's equation, the Nusselt numbers for mercury, lead-bismuth eutectic, and sodium-potassium alloy are calculated respectively. They are in good agreement with many experimental results. (auth)

11356 ON THE RELATIONS BETWEEN BASIC DESIGN OF ONCE-THROUGH BOILER AND THE CONTROL BEHAVIORS. Hajime Takenouchi. Gijutsu Kenkyusho Shoho, 13: No. 5-6, 21-7(Dec. 1963). (In Japanese)

The relations between the dynamic behavior of once-through boilers and the boiler designs are discussed. It is shown that the dynamic behavior is almost determined by diameters of tubes and the velocity of steam in the superheater (or pressure loss in superheater), assuming given steam conditions and a given arrangement of heating surfaces. The velocity of steam in the superheater is closely related to deviation of boiler outlet pressure. Hence, from the view-point of control and responsibility for quick load change, the lower velocity of steam in the superheater is better and it is advisable that the design point of the velocity should be set as low as possible. (auth)

11357 AN ANALYSIS OF BURNOUT CONDITIONS FOR FLOW OF BOILING WATER IN VERTICAL ROUND DUCTS. K. M. Becker and P. Persson (Aktiebolaget Atomenergi, Studsvik, Sweden). J. Heat Transfer, 86: 515-30(Nov. 1964).

A method of predicting the burnout conditions for flow of boiling water in vertical round ducts is presented. The analysis predicts that the burnout conditions are independent of the L/d ratio and the inlet temperature, and that the burnout steam quality decreases with increasing surface heat flux and increasing mass velocity. It was also found that the burnout steam quality at low pressures increases with the pressure, reaches a maximum at approximately 70 kg/cm^2, and thereafter decreases with a further increase of the pressure. The theoretical result compares very well with experimental data from different sources. (auth)

11358 AN ANALYTICAL STUDY OF HEAT TRANSFER IN NUCLEATE BOILING. Itaru Michiyoshi and Kunihiko Uematsu (Kyoto Univ.). Mem. Fac. Eng., Kyoto Univ., 26: 16-27(Jan. 1964).

Heat transfer in a steady state nucleate boiling is predicted theoretically by applying the theory developed for the incidence of the first bubble in transient boiling. The predictions are compared with experimental data or empirical correlations of water and Neo SK oil #350 (mixture of terphenyls). Some discussion is also presented on the preparation period of one cycle of bubbling. (auth)

11359 STABILITY OF AN ELECTROSTATICALLY SUPPORTED FLUID COLUMN. John M. Reynolds (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 8: 161-70 (Jan. 1965).

An analytical and experimental study was made of the cylindrical interface between two dielectric liquids under the influence of electrostrictive forces and surface tension. The analysis indicates that, for high-frequency applied fields such an interface can be stable. For stability, the applied voltage must be great enough to suppress surface tension effects and lower than some analytically determined critical value. For voltage greater than this critical value, experiments indicate that the interface is deformed in an unusual manner. (auth)

11360 THEORY OF STAGNATION-POINT HEAT TRANSFER IN IONIZED MONATOMIC GASES. Michael L. Finson and Nelson H. Kemp (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 8: 201-4(Jan. 1965).

Calculations of heat transfer similar to those of Fay and Kemp (J. Fluid Mech., to be published) were made for stagnation-point geometry for both the frozen and equilibrium boundary layers in ionized Ar and Xe. The results of these exact calculations are presented and compared with experimental data obtained previously. Stagnation-point boundary layer equations are obtained for momentum, equilibrium energy, frozen energy, and diffusion and solved to give stagnation-point heat transfer to an asymmetrical body and to a cylinder. (M.J.T.)

11361 A CORRELATION FOR FORCED CONVECTIVE BOILING HEAT TRANSFER TO HYDROGEN. J. W. H. Chi (Westinghouse Electric Corp., Pittsburgh). New York, American Inst. of Chemical Engineers, 1964, Preprint 38e, 35p, $0.50. (CONF-641201-1)

From American Institute of Chemical Engineers Annual Meeting, Boston.

Forced convection boiling heat transfer to hydrogen was studied in a literature review in an attempt to develop a correlation applicable to the wide range of conditions expected to occur during the startup of a nuclear rocket reactor. The film boiling regime, nucleate boiling, transitional boiling, heat transfer coefficients in single-phase gas, and heat transfer to vapor in film boiling are discussed. It was found that by the superposition of a boiling flux on a forced convective heat flux, a significant correla-

tion could be obtained for published data. The forced convective flux could be calculated from Sittus-Boelter type equations based on the film temperature, while the boiling flux was obtained from a correlation analogous to that for pool boiling. The boiling flux was a function of wall-to-bulk fluid temperature difference. The boiling flux correlation for hydrogen is shown to be independent of the flow orientation. (M.C.G.)

11362 THE CRITICAL HEAT FLUX — ITS INHERENT UNCERTAINTY AND VARIATION WITH SURFACE CONDITIONS. M. Carne (Atomic Energy of Canada Ltd., Chalk River, Ont.). New York, American Inst. of Chemical Engineers, 1964, Preprint 47b, 21p, $0.50. (CONF-641201-4)

From American Institute of Chemical Engineers Annual Meeting, Boston.

Studies were made of critical heat flux, which is defined as the minimum value of the surface average heat flux required to initiate a propagating local vapor film and as such is not subject to an inherent uncertainty. This definition was needed to allow for the fact that once the critical heat flux is reached or exceeded the time taken for a critical condition to occur is random. It was found that table nucleate boiling can persist above the critical heat flux for relatively long periods. The magnitude of the critical heat flux was found to be dependent on the surface conditions. (auth)

11363 VOID FRACTION MEASUREMENTS IN CAVITATING MERCURY. Frederick G. Hammitt, Willy Smith, Ian E. B. Lauchlan, Richard D. Ivany, and M. John Robinson (Univ. of Michigan, Ann Arbor). 38p. (CONF-446-71)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

A method using a gamma-ray densitometer was developed for obtaining precise measurements of local density (or void fraction) in an axially-symmetric two-phase flow, or of mean density in the centerline (or a parallel) plane. The method was applied successfully to a cavitating mercury venturi, and various basic measurements of the flow regime were obtained. The technique can be adopted for use with low-density fluids as water, alkali liquid metals, etc., but a softer radiation source would then be required. (auth)

11364 TRANSIENT EFFECTS IN TIEN'S NUCLEATE BOILING MODEL. Robert F. Boehm (General Electric Co., San Jose, Calif.) and John H. Lienhard. New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-34, 9p, $1.00. (CONF-763-14)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

It is shown that the conventional Yamagata equation for nucleate-boiling heat transfer in the region of isolated bubbles is only an approximation to an expression that should consist of the sum of transient and steady-stagnation-flow terms. It also shows that the wall temperature is fairly constant during boiling in the region of isolated bubbles, and that the frequency of bubble emission increases at $\Delta T^{0.7}$. (P.C.H.)

11365 LAMINAR FILM CONDENSATION IN THE PRESENCE OF AN ELECTROMAGNETIC FIELD. Ralph M. Singer (Argonne National Lab., Ill.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-47, 9p, $1.00. (CONF-763-18)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The use of an electromagnetic field to control the laminar film condensation of a vapor whose liquid is electrically conducting is proposed and analyzed. The condensate is pumped down a vertical wall by the field (similar to the action of an electromagnetic pump), thus eliminating the necessity of gravity without introducing moving parts. The effect of the parameters $c\Delta T/h_{fg}$, Pr, $g(\rho-\rho_v)/\delta B_0 E_0$, $(E_0/B_0)^2 H_{fg}$, and ξ (dimensionless coordinates) upon the condensate film thickness and the heat-transfer rate was studied. It was found that the rate of condensation can be significantly increased using an electromagnetic field over that obtained using the gravitational field. For example, the ratio of the condensation Nusselt number with gravitational and magnetic fields to that with only a gravitational field was about ten for sodium when $c\Delta T/h_{fg} = 0.001$, $B_0 = 20$ kilogauss and $E_0 = 10$ volts per in. (auth)

11366 THE PREDICTION OF LIQUID SUPERHEATS REQUIRED FOR INITIATION OF NUCLEATE BOILING IN THE LIQUID METALS. R. E. Holtz (Argonne National Lab., Ill.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-31, 11p, $1.00. (CONF-763-19)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An analysis was conducted to predict the liquid superheats that will be required to initiate nucleate boiling in the alkali metals. The classical two-phase mechanical and thermal-equilibrium equation was solved by applying a modeling of the behavior of the pressure in the liquid for water and the alkali metals. Curves are presented showing the liquid superheats required for nucleate boiling in sodium and potassium. (auth)

11367 EFFECTS OF ADDITIVES ON WETTING DURING MERCURY-POOL BOILING HEAT TRANSFER. L. T. Clark and M. F. Parkman (Aerojet-General Nucleonics, San Ramon, Calif.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-22, 7p, $1.00. (CONF-763-36)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The effects of additives on wetting during the pool boiling of mercury from the outside of horizontal tubes constructed of Haynes 25 and 9 Cr–1 Mo alloy was measured at one atmosphere of pressure (670°F). Cesium, rubidium, magnesium, and magnesium plus titanium were investigated at concentrations ranging from 0.05 to 0.21 wt %. Heat fluxes were varied from 5000 to 20,000 Btu/hr-ft^2. The existence of wetting was judged from whether nucleate or film boiling was obtained and was found to be a function of the type of material, type of additive, heat flux, and additive concentration. The 9 Cr–1 Mo alloy tube was more easily wetted than was the Haynes 25 tube. Magnesium plus titanium promoted wetting under all conditions. Rubidium and cesium promoted wetting at lower heat fluxes and higher concentrations but became less effective at higher heat fluxes and lower concentrations. Rubidium was somewhat more effective than cesium. Magnesium alone did not promote wetting. (auth)

11368 DEVELOPMENT OF A COMPACT MILITARY STEAM POWER PLANT. Paul N. Garay (Advanced Technology Labs., Mountain View, Calif.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-4, 8p, $1.00. (CONF-763-39)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The extent to which compact power plants may be modified, consistent with current state-of-the-art in design and construction, is discussed. (P.C.H.)

11369 END-WALL HEAT TRANSFER IN A RAREFACTION WAVE TUBE. B. T. Chao (Univ. of Illinois, Urbana). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-16, 5p. $1.00. (CONF-763-5).

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An analysis is presented for the end-wall heat transfer in a rarefaction wave tube based on the governing conservation equations and the measured free-stream temperature variation with time. The results compare very favorably with published data. Several temperature profiles are illustrated which confirm a posteriori the validity of the thin thermal boundary-layer assumption used. (auth)

11370 PROPELLANT HEATING STUDIES WITH WALL AND NUCLEAR HEATING. B. H. Anderson, S. C. Huntley, and D. J. Connolley (Lewis Research Center, Cleveland). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/AV-8, 12p, $1.00. (CONF-763-6)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A study of confined fluids subjected to nonuniform source heating, wall heating, and a combination of the two heat inputs was conducted. The study consisted of noncryogenic tests, liquid hydrogen tests with wall heating, and liquid hydrogen tests with nuclear heating. An analysis is presented that describes the temperature history of the fluid subjected to these types of heat inputs. The results of the analysis compare favorably with the results of the liquid hydrogen experiments. (auth)

11371 A COMPARISON OF METHODS FOR DETERMINING THE TRANSIENT RESPONSE OF A SHELL-AND-TUBE HEAT EXCHANGER. J. C. Wyngaard and F. W. Schmidt (Pennsylvania State Univ., University Park). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-20, 12p, $1.00. (CONF-763-3)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Exact solutions for a counterflow shell-and-tube heat exchanger, in Laplace-transformed form, are presented for the response of the outlet-fluid temperatures to step changes in inlet temperatures or flow rates. A simple numerical method is presented for the inversion of these functions to give the exact transient response of the heat-exchanger fluids. For a particular heat exchanger, transient-response results obtained from electrical analogy, and from a numerical (Dusinberre) method were compared to the exact results. A compensating-error effect was found in the Dusinberre method, which gave very accurate results with the proper choice of space and time increments. (auth)

11372 FREE-CONVECTION HEAT-TRANSFER COEFFICIENTS FROM RECTANGULAR VERTICAL FINS. John R. Welling (Western Military Electronics, Motorola, Inc., Scottsdale, Ariz.) and Charles B. Wooldridge. New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-33, 8p, $1.00. (CONF-763-42)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Vertical-rectangular-finned surfaces were used to effect heat transfer on much equipment. Lack of data showing the effect of various fin geometries on free-convection heat transfer prompted the experimentation. The results provide preliminary design data. For a given temperature, an optimum value of the ratio of fin height to the distance between fins is indicated. The way this ratio varies with fin temperature is also given. (auth)

11373 LIQUID HEAT-TRANSFER COEFFICIENTS FOR POTASSIUM DURING VERTICAL UPFLOW INSIDE A TUBE. S. G. Sawochka (General Electric Co., Evendale, Ohio) and D. J. Schleef. New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-19, 8p, $1.00. (CONF-763-26)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Liquid heat-transfer coefficients for potassium were measured at a Prandtl number of 0.004 during vertical upflow in a tube between 700 and 810°F in an annular cocurrent test section using a sodium coolant. Values of the potassium Nusselt number are presented for Peclet numbers from 80 to 350 and indicate substantially lower heat-transfer performance than that theoretically predicted. Thermocouples imbedded in the wall of the test section's thick-walled nickel tube permitted calculation of the potassium tube side heart-transfer coefficient without an a priori assumption of the ratio of the tube-to-annular resistances. Possible reasons for the departure from the theory of low-Prandtl-number liquid heat-transfer performance are presented, considering both experimental errors and the shortcomings of current analytical techniques. (auth)

11374 FILM-THICKNESS MEASUREMENTS. J. G. Collier and G. F. Hewitt (Atomic Energy Research Establishment, Harwell, Berks, Eng.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-41, 19p. $1.00. (CONF-763-37; AERE-R-4684)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Various methods that have been used for the measurement of the thickness of aqueous liquid films are described and practical applications are discussed. The methods are divided into three main headings, including film average and localized methods. (P.C.H.)

11375 ADVANCED TEST REACTOR BURNOUT HEAT-TRANSFER TESTS. M. W. Croft (Babcock and Wilcox Co., Lynchburg, Va.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-14, 9p, $1.00. (CONF-763-30)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Burnout tests at low pressure and high mass flow rates were conducted on channels of three sizes (4 ft by 0.054, 0.072, and 0.094-in.) to determine whether power input was limited by normal heat flux burnout as it normally is or by autocatalytic vapor binding when the coolant reached saturation, as had been indicated by preliminary calculations. Pressure was varied from 80 to 250 psia, mass velocity from 5.5×10^6 to 12.5×10^6 lb/hr-ft^2, and inlet temperatures from 120 to 240°F. Power input to the smaller channels was limited by flow instability or autocatalytic vapor binding to a value that produced coolant saturation. Burnout flux, which varied from 0.95×10^6 to 3.88×10^6 Btu/hr-ft^2-deg F, limited power input to the 0.094-in. channel. (auth)

Materials Testing

Refer also to abstract 12761.

11376 RADIOGRAPHY IN THE PRESENCE OF BACKGROUND RADIATION. R. W. McClung (Oak Ridge National Lab., Tenn.). Mater. Evaluation, 23: 41-5(Jan. 1965).

Experiments were carried out to determine how much fogging radiation can impinge on a film and still produce a useful radiograph and what, if anything, can be done to salvage a film, which has received an excessive amount of non-image-forming radiation from the background. The arbitrarily selected specimen for the study was a step wedge of aluminum. On each step were cemented three penetrameters with thickness of 1, 2, and 4% of step thickness. The primary x-ray exposures were made at 50 kvp and the background fog was supplied by another x-ray unit and a ^{60}Co source. It was concluded that useful radiography can be performed despite the presence of a non-image-forming radiation background. With the energies used, the tolerance to the x-rays seemed to be lowest at 100 kvcp, slightly better at 50 kvcp, and best at 300 kvcp. With no chemical reduction, a slightly improved tolerance seemed to prevail if the original exposure conditions were intended to produce a density of 2.0 on a non-fogged radiograph. The tolerance to background radiation was increased approximately 16 times through the use of chemical reduction on the exposed film. (M.C.G.)

11377 THERMAL NEUTRON RADIOGRAPHY BY THE USE OF SMALL NUCLEAR REACTOR. Kazuyuki Ogawa and Nobuyoshi Wakabayashi (Tokyo Shibaura Electric Co., Ltd.). Oyo Butsuri, 33: 334-41(May 1964). (In Japanese)

Thermal neutron radiography by the use of Toshiba Training Reactor (max output 100 Kw) was studied with respect to its possible use as an industrial testing device of low cost. A neutron beam of Cd-ratio 3.5 (In) from the reactor core collimated with a collimator of simple design gives fairly good pictures by the image transfer method with an In screen. The effectiveness of the collimator for imaging is discussed with relation to the energy spectrum of neutrons in the reactor. Several neutron radiographs and ordinary x-ray radiographs are shown for comparison. A cadmium shadowing method is newly introduced for sensitive detection of hair cracks and porous portions in the sample. Heavily irradiated radioactive nuclear fuel in the form of a UO_2 pellet was radiographed to prove that the thermal neutron radiography is free from γ-ray fogging. The effects of scattering of neutrons in sample materials on the resolving power are briefly discussed. (auth)

11378 IMPROVEMENTS IN OR RELATING TO MATERIALS TESTING APPARATUS. Frederick William Friars, Claude Williams, and Roderick Michael De'Ath (to United Kingdom Atomic Energy Authority). British Patent 972,583. Oct. 14, 1964. Filed Oct. 22, 1962.

Materials testing apparatus for applying stress to specimens and suitable for disposition within the core of a nuclear reactor is described. The apparatus is comprised of a load member of generally cylindrical shape, a support member, pivotable linkage means interconnecting load and support members, and means for interconnecting at least one specimen between the support member and the linkage means so that the specimen is stressed when opposing forces are exerted on the load and support members. Preferably, the load and support members and the interconnecting means are disposed coaxially, and double means are employed to provide a substantially longitudinal load on the specimens. In an operating position, the load member and specimens are suspended from the support member. (A.G.W.)

11379 METHOD OF AND EQUIPMENT FOR THE NON-DESTRUCTIVE TESTING OF STEEL PRODUCTS. (to Huttenwerk Oberhausen AG). British Patent 973,322. Oct. 21, 1964. Priority date Apr. 4, 1962, Germany.

A nondestructive method of testing steel products for oxide inclusion by irradiating the test material with neutrons and determining the gamma-active points or regions resulting from the presence of any inclusion is described. Fast neutrons react with oxygen to from ^{16}N, and γ radiation of about 6 Mev is emitted upon disintegration of the ^{16}N. The γ radiation can be measured outside the piece by photographic plates or films or by γ detectors such as scintillation counters. Any neutron source emitting neutrons of energy greater than 7 Mev at a sufficiently high rate may be used, but the preferred source is a deuterium accelerator with a tritium target. Irradiation for 10 to 30 sec is required. The limiting sensitivity of the method is about 10^{-7} g. The method is applicable to cold, hot, or even red-hot materials. (A.G.W.)

Protective Structures

Refer also to abstract 11414.

11380 (DASA-1406) A STUDY OF LOADS ON UNDERGROUND STRUCTURES. FINAL REPORT. PART I. AN ANNOTATED BIBLIOGRAPHY. D. A. Van Horn. PART II. CURRENT KNOWLEDGE OF TIME-DEPENDENT LOAD EFFECTS. R. K. Tener. PART III. AN ANALYTICAL METHOD FOR DETERMINING LOADS. D. A. Van Horn. PART III (SUPPLEMENT). GRAPHICAL REPRESENTATION OF ANALYTICAL EXPRESSIONS. D. A. Van Horn (Iowa Engineering Experiment Station, Ames). 1963. Contract DA-49-146-XZ-085. 40p. (AD-420528). $10.50(OTS).

An annotated bibliography is presented in which the main purpose is to list earlier studies of loads on underground structures. A discussion is presented of three of the current procedures for design of underground structures in which nuclear effects are given consideration. An analytical method is given for determining loads resulting from time-dependent overpressures. This is supplemented by a graphical representation of the expressions developed. (OTS)

11381 (WL-TDR-64-28) RESPONSE OF FOAM-ISOLATED TUNNEL LININGS TO TRANSIENT LOADINGS. Final Report. E. M. Naureckas and W. F. Riley (Illinois Inst. of Tech., Chicago. IIT Research Inst.). June 1964. Contract AF29(601)-6022. 57p. (AD-603539). $3.00(OTS).

This research program was conducted to determine the behavior of a foam-isolated tunnel liner in an elastic material during passage of a plane stress wave. The specific objectives of the program included a determination of time-dependent stress fields in the elastic material, time-dependent magnitudes and location of crushing in the isolation material, and time-dependent stresses and motions of the tunnel liner. The results of the program indicate that the stresses in the liner are significantly reduced by the crushing of the foam. The rigid body motions of the liner, however, are not significantly influenced by the presence of the foam. (auth)

11382 BLAST-WAVE PROPAGATION IN HYDRAULIC CONDUITS. P. Lieberman (Illinois Inst. of Tech., Chicago). J. Eng. Power, 87: 19-28(Jan. 1965).

The problem of isolating a water pipe system from the effects of a long duration blast wave resulting from a nuclear explosion is discussed. For an impact load of constant amplitude, the load at the end of the pipe has twice the magnitude of the impact load at the entrance of the pipe and has a duration dependent upon the pipe length. However, certain blasts have pressure-time histories which can induce even higher reflection factors than the usual factor of 2. These pressure-time histories, acting upon a water column in a closed-end pipe, are analyzed by a time-position wave diagram. (auth)

11383 CONTAINMENT-VESSEL LEAK-RATE TESTING. G. C. Robinson. Nucl. Safety, 6: No. 1, 69-72(1964).

Work in progress to establish leak rates of components for both containment and confinement structures is reviewed. The "reference" technique of leak testing and of the errors in such testing are discussed. It was concluded that leak rates of 1% or less may be attained in both specially constructed metal-panel buildings and concrete enclosures up to pressures not exceeding 0.5 and 5.0 psi, respectively. (M.C.G.)

Space Propulsion

Refer also to abstracts 12639 and 12817.

11384 (D2-20646) CHARACTERISTICS OF ION PROPULSION. Electrical Propulsion Handbook. Volume III. William F. Braerman (Boeing Co. Aero-Space Div., Seattle). Feb. 1963. 99p.

The basic principles and problems associated with the ion electric propulsion system are reviewed. The state of the art of various engine concepts, as well as anticipated performance boundaries, are presented. (auth)

11385 (NASA-TN-D-2635) FIELD-ENHANCED THERMIONIC EMISSION FROM ELECTRODES OF CESIUM ION THRUSTOR. Joseph F. Wasserbauer (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Jan. 1965. 13p. $1.00(OTS).

The drain currents owing to thermionic emission from cesium-coated tantalum accelerator electrodes of an ion thrustor are estimated. The effect of electric field strength at the accelerator electrode is included. The ion thrustor was tested at current densities of 58 and 100 amperes per square meter over a range of accelerating potentials. Agreement was obtained between the experimental data and the calculated values based on the assumptions used. (auth)

11386 IONIC PROPULSION. J.-M. Dolique (Faculte des Sciences, Grenoble, France). Rev. Franc. Astron., No. 3, 83-95(May-June 1964). (In French)

After a comparison of electric and chemical propulsion methods of space flight, the regions of interest of the various types of propulsion are defined. The design and performance of an electrostatic propulsion unit are studied. The present state of development of ionic propulsion and its future prospects are indicated. (J.S.R.)

11387 UTILIZATION OF ANNIHILATION FOR PROPULSION OF PHOTON ROCKETS. V. S. Potapkin. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 4, 3-13(July-Aug. 1964). (In Russian)

The mechanism of p-$\bar{p}$ reaction and the possibility of using the reaction in rocket propulsion were analyzed. The problem of focusing the produced beam by means of electric and magnetic fields is discussed. (tr-auth)

11388 A CRITICAL DISCUSSION ON THE PLANNING CONSIDERATIONS OF ELECTRIC PROPULSION FOR

SPACE MISSIONS. John W. Stearns (California Inst. of Tech., Pasadena). 26p. (CONF-640901-16)

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1964.

A discussion of a paper by B. Pinkel is given. It is to be noted that consideration of electric propulsion development cannot be taken out of the context of the development of the entire field of advanced propulsion. This discussion therefore provides a comparison of the present major technology programs in advanced propulsion on the basis both of technological state-of-the-art and of missions capability. Some additional features concerning the economic problems of deep space exploration are provided which may seriously limit the application of any form of advanced propulsion to unmanned exploration. For manned planetary exploration, it is entirely possible that a combined system utilizing both nuclear and electric propulsion systems is more reasonable than either propulsion system alone. (auth)

GEOLOGY AND MINERALOGY

General

11389 (CU-2663-17) MIXING AND RESIDENCE TIME ON THE GREAT BAHAMA BANK. J. Michael Costin (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Jan. 1965. Contract AT(30-1)-2663. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Many studies of regular and random motions were made in the shallow waters of the Great Bahama Banks. Dye tracer experiments were made near the edge of the shoal water-deep water boundary and at positions 20 and 50 miles in from the edge on the western banks in the lee of Andros Island. These studies are discussed with regard to circulatory patterns and flushing times. Estimates are made of the magnitude of horizontal shearing stresses during the ebb and flood periods under conditions of wind and current moving in the same and opposing directions. A two-dimensional model is proposed which gives the time in days for a particle to move from the experimental areas to the edge of the bank during the summer season. The computed values are in close agreement with the experimental results. (auth)

Natural Radioactivity and Fallout

Refer also to abstracts 10731, 11417, 11421, and 11477.

11390 (AWRE-T-57/58) OPERATION BUFFALO. PART 5. THE ENTRY OF FISSION PRODUCTS INTO FOOD CHAINS. J. F. Loutit, ed. (Gt. Brit. Medical Research Council. Radiobiological Research Unit, Harwell, Berks, England) and R. Scott Russell, ed. (Gt. Brit. Agricultural Research Council. Radiobiological Lab., Grove, Berks, England). May 1959. 216p. Dep.(mn).

Investigations carried out both at Maralinga during Operation Buffalo and in the United Kingdom are described. The extent to which fallout was retained on pastures of types familiar in European agriculture was variable but, when the particle size of the deposition was relatively small, 15 to 20% of the deposit was found on the foliage. Less retention is, however, likely when a deposit is of large particle size. The retention of fallout by ripe ears of wheat appeared to be a minor source of hazard to man relative to the contamination of pastures grazed by dairy cattle. The solubility of fallout deposited on the ground surface, and also collected from radioactive cloud by aircraft, was examined. Relatively high solubility, indicative of ready biological availability, was observed in all cases except the near-in ground deposit after a tower shot. Even this material showed appreciable solubility. Experiments with rabbits and cows showed that the biological availability of fission products collected from the radioactive clouds of three weapons was not significantly reduced by its physical form. Some evidence was obtained that the same was true for the near-in ground deposit after a ground shot. Studies of the metabolism of fallout by sheep, rabbits, and cows confirmed expectations that isotopes of iodine and strontium are the major sources of hazard through ingestion. Shorter lived fission products such as tellurium and molybdenum were metabolized to an appreciable extent; they were, however, shown to be minor sources of hazard relative to the isotopes of iodine and strontium. The extent to which different isotopes of iodine contribute to the dose to the thyroid soon after the detonation of a weapon was examined. The results indicate that valid conclusions regarding the metabolism by animals of fission products from fallout can be reached by laboratory experiments using soluble preparations of chemically separated isotopes. (auth)

11391 (NP-14658) STUDIES ON THE BIOLOGICAL CONCENTRATION OF FISSION PRODUCTS IN MOLLUSCS FROM WATER, WITH SPECIAL REFERENCE TO AN INDEX OF RADIOACTIVITY IN WATER. Final Report, October 1961. A. Berg, Margaret Merlini, O. Ravera, and V. Tonolli (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and Italy. Istituto Italiano di Idrobiologia, Pallanza). IAEA Contract No. 59. 230p. Dep.(mn).

Results are reported from measurements of the radioactivity of the flora and fauna of Lake Maggiore, Italy, due to natural sources and fallout made from 1952 through 1960. The contribution of natural sources of radiation is discussed. Emphasis is placed on the content of ^{137}Cs and ^{90}Sr from fallout in samples of water, sediments, plankton, marine benthonic organisms, algae, mollusks, and fish, and aquatic plants collected throughout the period. Data are included from a study of the metabolism of ^{54}Mn in snails in a balanced aquarium. The data show that the snail Viviparus accumulated more ^{90}Sr than either the bivalve Unio or the fish Scardinius, on an equal weight basis, and the water plant Anacharis accumulated ^{90}Sr at approximately the same rate as Viviparus. It was concluded that ^{89}Sr and ^{90}Sr discharged into an environment like Lake Maggiore would be rapidly accumulated by the water plants, such as Anacharis, by sediments, by mollusks, primarily Viviparus, and their empty shells, and eventually by the skeleton of fish. (125 references) (C.H.)

11392 (NP-14683) ACTIVITY REPORT OF THE NUCLEAR CHEMISTRY LABORATORY ON FALLOUT MEASUREMENTS FOR THE PERIOD NOVEMBER 1961–FEBRUARY 1964. C. B. Senvar, M. Ergin, O. Birgül, and F. Usul (Turkey. Atomic Energy Commission, Ankara). 1964. 41p. Dep.(mn).

Results are presented of radioactive fallout measurements for air (gross β), water (gross β), milk (gross β and ^{90}Sr), and soil (^{90}Sr) in the Ankara area and for precipitation and drinking water samples (gross β) and vegetables (gross β) all over the country. (D.L.C.)

11393 ON THE PROBABLE CONSEQUENCES OF THE NEW CYCLE OF SOVIET NUCLEAR EXPLOSIONS. Alberto Cozza (Sanità Militare Marittima, Rome). Ann. Med. Navale (Rome), 67: 3-18(Jan.-Feb. 1962). (In Italian)

The estimated biological effects caused by nuclear fallout from the Soviet nuclear explosions of Sept. 1961 are discussed. Attention is given to how much of the yield is provided by fusion and how much is derived from fission reactions. It is evident that many of the parameters concerning Soviet explosions are only approximate values. The amount of fissionable fallout material in the northern hemisphere must be considered in relation to the total global fallout. No definite ideas are agreed upon concerning the time element of the stratosphere-migrating isotopes. Formerly, it was assumed that the average half-life of the fallout material is about ten yr, but later it was reduced to five. Today it is assumed that it is closer to two to three yr and that it is of much shorter duration if the fissionable materials are injected into the polar-circle stratosphere. Data available on fallout from U. S., British, and Soviet nuclear explosions are summarized and possible biological effects on present and future generations are discussed. (T.C.O.)

11394 ^{90}Sr REMOVAL IN VEGETABLES PREPARED FOR HOME CONSUMPTION. J. C. Thompson, Jr. (Cornell Univ., Ithaca, N. Y.). Health Phys., 11: 136-7(Feb. 1965).

Home preparation and cooking procedures for cabbage, carrots, green beans, onions, potatoes, and tomatoes removed from 19 to 55% of the ^{90}Sr content of these 6 vegetables that make up nearly 75% of the total vegetable consumption in the U. S. Tomatoes were washed and sliced and the other vegetables were washed and boiled after

preliminary preparation. All vegetables were analyzed for ^{90}Sr and Ca content before and after preparation and measurements were also made of the ^{90}Sr content in soils in which the vegetables were grown. Results indicate that root vegetables contain more ^{90}Sr than above ground edible parts and that the ^{90}Sr content of vegetables can be greatly reduced by home preparation methods. (C.H.)

11395 REMOVAL OF RADIONUCLIDES FROM MILK. G. K. Murthy and J. E. Campbell (Robert A. Taft Sanitary Engineering Center, Cincinnati). J. Dairy Sci., 47: 1188-93(Nov. 1964).

In the cationic radionuclide removal process, the milk obtained after Ca:Mg:K:Na resin treatment and neutralization with KOH is satisfactory and acceptable for drinking. However, analysis of the inorganic composition of resin-treated milk neutralized either with Dowex 2-X8 (OH^-) anionic resin or KOH showed that the milk is an altered product. To maintain the inorganic composition unaltered, milk must be neutralized with an anionic resin. Removal of ^{131}I and restoration of anionic composition during neutralization of milk acidified and treated with cationic resin in the Ca:Mg:K:Na cycle employed for the removal of cationic radionuclides from milk was investigated. Milk labeled with ^{131}I in vitro was acidified to pH 5.35 with citric acid and then restored to pH 6.8 by the batch process with the addition of 1.0 to 1.2 g Dowex 1-X8 ($Cl^-:OH^-$) resin per 100 ml of milk at 45-sec intervals. The resin in the chloride cycle, conditioned with NaOH and HCl to eliminate free amines, was previously equilibrated with 1.5N NaOH by the column batch technique so as to yield a $Cl^-:OH^-$ ratio of 0.850:0.150. Analysis of treated milk indicated that about 96.5 ± 1.2% of ^{131}I and 85.2 ± 5.6% of excess of citric acid were removed, and that the neutralization process increased the chloride content by 7.0 ± 1.0% and decreased inorganic phosphate content by 35.3 ± 2.2%. Approximately 12 to 14 g of resin were required to neutralize 100 ml of milk. The removal of ^{131}I was greatly influenced by the (OH^-) in the resin phase and by the rate and extent of neutralization. The totals of anionic components of treated and untreated milks were comparable, which is an improvement over the previously described methods of neutralization. (BBB)

11396 ION-EXCHANGE PROCESSES FOR REMOVING RADIOACTIVE CONTAMINATION FROM MILK. L. F. Edmondson (Dept. of Agriculture, Washington, D. C.). J. Dairy Sci., 47: 1201-7(Nov. 1964).

Extensive data are presented on various methods for removing radioactive contamination from milk. Attempts were made to develop a feasible standby process for use in dairy plants in the event that radioactive fallout should reach hazardous levels. Current levels of all the radioactive contaminants are far below what is considered hazardous levels. Iodine-131 is essentially undetectable in all milk supplies. However, the remote possibility of an unforeseen nuclear reactor accident, or resumption of nuclear testing by any nation, would result in significant increases in fallout. Emphasis is placed on a fixed-bed column process for removing radiostrontium; commercial feasibility is more nearly established for its use than for other procedures, or for removal of the other major radionuclides (^{137}Cs and ^{140}Ba). A pilot plant procedure is described and is now being evaluated on a scale of 12,500 lb/hr (100,000 lb/day) by a commercial dairy plant. The cost of operating the fixed-bed process described is estimated at 1.0¢ per quart of milk when USP grade salts are used. If technical grades of chloride salts are used for regeneration, the cost is estimated at 0.5¢ per quart. These costs are based on pilot plant experience and include estimates for investment, investment burden, labor, and normal operating costs. An integrated pilot plant process has also been arranged for removing both ^{131}I and radiostrontium by passing milk first through the anion resin column, then acidifying to pH 5.3 and passing it through the cationic resin. Another phase of the isotope removal investigations includes the use of a continuous ion exchange contactor. Such a continuous countercurrent system has inherent advantages with respect to efficiency and product uniformity. Other processes for removing radiostrontium investigated included several exchangers with special functional groups (carboxylic, phosphorous, and phosphoric acid resins, zeolite inorganic exchangers, a chelating resin, and a zwitterion). The most promising was an intermediate-strength carboxylic acid resin. A method of removing radiostrontium from milk by precipitating it with an excess of calcium phosphate was also investigated. (BBB)

11397 EFFECT OF TEMPERATURE OF REGENERANT ON REMOVAL OF RADIONUCLIDES FROM ION EXCHANGE RESINS. D. G. Easterly, H. E. Walter, and L. F. Edmonson (Dept. of Agriculture, Washington, D. C.). J. Dairy Sci., 47: 1263-5(Nov. 1964).

A study was made of the effect of temperature of regenerant (stripping) solutions on the removal of radionuclides (^{131}I, ^{85}Sr, and ^{134}Cs) from resin columns. Milk in vivo-labeled with ^{131}I (1 μC/l) was passed through five separate columns of anion resin (Dowex 2 × 8). The effect of flow rate of the regenerant (2N HCl) through the columns on the removal of ^{131}I from the resin at 76° and 160°F was studied. The removal of ^{131}I from the resin increased significantly with increasing temperature of 2N HCl. Similar results were obtained with ^{85}Sr. The regeneration was more effective at the higher temperature, with a savings of regenerating solution. This difference was more pronounced in the case of ^{85}Sr than with ^{134}Cs. About 60% as much solution was needed for the same amount of ^{85}Sr. When removing Cs from milk, the removal drops to below 90% after 12 to 15 bed volumes of milk have been passed through the resin column. However, this could still be incorporated into a feasible operation, because of the relatively small amount of solution needed for stripping and regeneration. The advantage gained by heating the solutions may be partially offset by the added expense of heating. However, a definite advantage of such a daily operation may be the reduction of bacteria in the resin columns. If this method were used as means to control bacteria, the two advantages thus gained should more than compensate for the added cost of heating the regenerating solutions. The reduction in operating time would also be an advantage. (BBB)

11398 NATURAL VARIATIONS IN THE ABUNDANCE RATIO AND THE ATOMIC WEIGHT OF COPPER. W. R. Shields (National Bureau of Standards, Washington, D. C.), S. S. Goldich, E. L. Garner, and T. J. Murphy. J. Geophys. Res., 70: 479-91(Jan. 15, 1965).

The absolute ratio $^{63}Cu/^{65}Cu$ was determined for 106 samples that include a variety of copper minerals. Relative to a reference copper sample with a previously determined absolute ratio of 2.2440 ± 0.0021, variations range from −0.9 to 0.33% (0.15% = 95% confidence limit of a single determination). No significant variations were found for chalcopyrite, tetrahedrite, enargite, or in the Canyon Diablo and Bruderheim meteorites. Some samples of bornite and of chalcocite exhibit variations with enrichments in either ^{63}Cu or in ^{65}Cu. Secondary oxides of copper show significant enrichment only in the heavy isotope. The relative variations previously reported by Walker, Cuttitta, and Senftle for samples from the Cougar mine, Colorado, are confirmed. A mean value of 2.2431 for 82 mineral samples probably is unduly weighted with the rarer secondary minerals that are enriched in ^{65}Cu. The ratio $^{63}Cu/^{65}Cu$ for bulk or commercially processed copper is very near the value of 2.2440, and the atomic weight of such copper is 63.5455 ± 0.0010. The causes of the natural variations in copper abundance ratios are not known. Unless otherwise stated the indicated uncertainties are over-all limits of error based on 95% confidence limits for the mean and on allowances for effects of known sources of possible systematic error. (auth)

11399 RADON CONTENT OF RAINWATER. Partha Banerji and S. D. Chatterjee (Jadavpur Univ., Calcutta). Nature, 204: 1185-6(Dec. 19, 1964).

Measurement of Rn in samples collected during a rainy season in Calcutta is discussed. The specific activity of the Rn varied from 5×10^{-12} to 3×10^{-12} C/l. The specific activity diminished with the amount of rainfall. Data confirmed the diurnal variation of the Ra content of the atmosphere. (J.R.D.)

11400 STRONTIUM-90 AND CAESIUM-137 IN ANTARCTIC SNOWS. R. N. Woodward (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Nature, 204: 1291(Dec. 16, 1964).

Data on ^{137}Cs and ^{90}Sr contents in Antarctic snow from 1939 through 1961 are tabulated. The ^{90}Sr determinations show a major influx of ^{90}Sr in winter 1955 following smaller depositions in 1953, 1954, and summer 1954/55. The ^{137}Cs results appear completely chaotic. Appreciable ^{137}Cs was found in the 1939 and 1940 samples-13 years before the first thermonuclear device was detonated in November 1952. The ^{137}Cs results suggest, therefore, either contamination, or migration of ^{137}Cs in Antarctic snows. (P.C.H.)

11401 THE CHARACTERISTIC NATURAL AND ARTIFICIAL RADIOACTIVITY OF METEOROLOGICAL BODIES OF AIR AT 700 AND 1800 m SEA LEVEL. Reinhold Reiter (Fraunhofer-Gesellschaft zur Forderung der Angewandten Forschung, Garmisch-Partenkirchen, Ger.). Nukleonik, 6: 313-20(Oct. 1964). (In German)

For the time period from 1959 to 1963, with the help of uninterrupted measurements of the components of air radioactivity at 700 and 1800 m, the characteristic concentrations of ^{214}Pb, ^{212}Pb, and nuclear decay products in the different meteorological air bodies could be determined. The influences of the source and movement of the air bodies on their radioactivity content are shown. (M.C.G.)

11402 RADIOACTIVITY MEASURED IN ALASKAN NATIVES, 1962-1964. Harvey E. Palmer, Wayne C. Hanson, Bobby I. Griffin, and Leslie A. Braby (General Electric Co., Richland, Wash.). Science, 147: 620(Feb. 5, 1965).

Measurements of the cesium-137 content of northern Alaskan natives during the summer of 1964 indicated that the adults of the interior village of Anaktuvuk Pass had the highest average body burden: 1280 nanocuries of cesium-137. This is an increase of 200 percent over the average body burden found in the summer of 1962 and 100 percent over that found in the summer of 1963. The greatest burden found in a native in 1964 was 2.4 microcuries of cesium-137, but the highest burden of all, 3.0 microcuries, was measured in a non-native living mainly on caribou meat. Sodium-22 was found in samples of urine from Eskimos, and subsequently in the Eskimos themselves and in reindeer and caribou meat. (auth)

Site Survey and Selection

Refer to abstracts 11819 and 12793.

Techniques and Equipment

11403 (NP-14678) SALMON. Long Range Seismic Measurements of VELA UNIFORM Project 8.4. Seismic Data Laboratory Report No. 113. (Teledyne Systems Co. UED Earth Sciences Div., Pasadena, Calif.). Oct. 22, 1964. 25p.

SALMON, a 5-kt underground nuclear test, was detonated in the Tatum Salt Dome in Mississippi on Oct. 22, 1964, as part of the project for developing methods for distinguishing between explosions and earthquakes. The data that are presented include principal phases, magnitudes, travel times, maximum amplitudes, etc. (D.L.C.)

11404 (NVO-1163-24) GROUND MOTION PREDICTIONS, PAHUTE MESA. L. B. Luhrs (Beers (Roland F.) Inc., Alexandria, Va.). June 9, 1964. Contract AT(29-2)-1163. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Empirical prediction equations were used to calculate ground motions at distance for events U9ao, U10e, and U10c at Yucca Flat, and the predicted particle accelerations, displacements, and velocities are compared with observations. Further predictions were made for hypothetical events of yields 175, 350, 700, 1000, and 1500 kt at Pahute Mesa. The effects of deep alluvium are considered. (D.L.C.)

11405 THE USE OF RADIOISOTOPES FOR SOIL PHYSICAL MEASUREMENTS. THE NEUTRON SCATTERING METHOD FOR MEASURING SOIL MOISTURE. Vagner Haahr (Atomenergikommissionen, Riso, Denmark). Grundforbattring, 4: 295-315(1963). (In Danish)

In the technic described measurements were done with a Nuclear Chicago d/M portable unit comprising an electronic scaler, a surface moisture probe (P-21), and a sub-surface moisture probe (P-19). For various Danish soils the relations between moisture content and count rate were determined. The technic employed for calibrating the subsurface probe is shown. Since the neutron scattering method is in effect a measure of the hydrogen content in soils, it is emphasized that the presence of organic matter in the soil does affect the results. For example, one % of humus in a soil is equivalent to the hydrogen content of 0.5% of water. For Danish soils this factor should be of minor importance since the humus content in most Danish subsurface soils is of the order of 0 to 0.5%. As regards the influence of neutron-absorbing elements on the measurements, only chloride and boron are considered as important for Danish soils. With an increase in soil density an increase in the count rate was found for the subsurface probe. This relation did not apply to the surface probe. A difference in density of the subsurface soil of 0.1 g/cm^3 altered the count rate ~ equal to a difference of 1% of moisture. The volume of soil measured by the neutron-scattering technic varied with the moisture content and thus cannot be defined exactly. The results obtained in these experiments are in agreement with those obtained previously. Although the calibration curves varied with soils from different localities, it was found that, in general, two calibration curves are sufficient to meet the requirements for the common Danish soil types examined, namely one curve for clay soils and one for sandy soils. (BBB)

11406 GEOCHEMICAL APPLICATION OF SPARK SOURCE MASS SPECTROGRAPHY. S. R. Taylor (Australian National Univ., Canberra). Nature, 205: 34-6 (Jan. 2, 1965).

The use of a spark source mass spectrograph for the analysis of geological materials is discussed. A brief account of the technique is given. The precision of the method appears to be of the order of 10%, and the instrument shows rather uniform sensitivity, with variations up to a factor of 3 or 4. The instrument is well suited to the determination of the rarer elements in geological materials, particularly those with isotopes of mass greater than 90. The lighter rarer elements, Li and Be, suffer interference from multiply charged Si and Al, but boron can be determined using ^{11}B. The results for a number of elements are tabulated. (P.C.H.)

11407 METAMORPHISM AND MINERAL IDENTIFICATION BY GAMMA RAY METHODS. R. C. Murty (Univ. of Western Ontario, London, Can.). Nature, 205: 60-1(Jan. 2, 1965).

A nondestructive analytical method is proposed for determining metamorphism and mineral identification by gamma attenuation. The computed gamma absorption coefficients for the mineral plagioclase $(Na,Ca)Al_2Si_2O_8$, chlorite $(Mg,Fe,Al)_6(Al,Si)_4O_{10}(OH)_8$, and epidote $Ca_2(Al,Fe)_3Si_3O_{12}(OH)$ for the energy range 0.01–100 Mev are tabulated. In the energy range 0.1–5 Mev, Compton effect is the predominant interaction and only the electron density can be obtained. However, at very low energies where the photoelectric effect is predominant, and high energies where pair production predominates, the interchangeable heavy and light elements in a mineral can be distinguished. After identification of the mineral the specimen can still be used to investigate its elastic, thermal, electrical, and magnetic properties. (P.C.H.)

11408 APPARATUS FOR BRINGING ISOTOPES INTO BORE HOLES. Jerzy Krotowicz. Przeglad Geol., 12: 417-18(Oct. 1964). (In Polish)

In hydrogeological researches carried on by means of radioactive isotopes it is necessary to bring isotope liquids into bore holes to a given depth. For this purpose an apparatus was constructed in which the explosion force of explosives has been used for crushing ampoule with isotope and for dispersing isotope liquid in bore hole.

The apparatus allows to bring down the radioactive isotope liquid to any depth. The weight of the apparatus is 5.5 kg, diameter 76 mm, hence it may be applied to bore holes of a diameter more than 3 inches also, the apparatus works without fail at any depth of bore hole. (auth)

11409 EXPLOSION SEISMOLOGY. E. W. Carpenter (United Kingdom Atomic Energy Authority, Blacknest, Brimpton, Berks, Eng.). Science, 147: 363-73(Jan. 22, 1965).

Current research trends in seismology, which are specifically directed toward solving the problems of detecting, locating, and identifying underground nuclear explosions, are described. The majority of the work to date was directed toward obtaining an understanding of seismic propagation paths in the crust and upper mantle. (H.D.R.)

Thorium and Uranium Minerals

11410 (TID-21435) GEOLOGIC ASPECTS OF THORIUM RECOVERY FROM COMMON ROCKS. Annual Report, June 1, 1963–May 31, 1964. (Rice Univ., Houston, Tex.). For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], subcontract 1491. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Data are tabulated for the Th, U, and K contents of 28 samples of Conway granite from the 600- to 710-ft interval. The average Th content is 54.4 ppm, and site studies show that most of the Th is contained in thorite, huttonite, and monazite grains. Studies of granite from Fitzwilliam, N. H., and of Weston gneiss from Vermont are discussed briefly. Thorium recovery from low-grade placer sand deposits is considered. (D.L.C.)

11411 (TID-21612) GEOLOGIC ASPECTS OF THORIUM RECOVERY FROM COMMON ROCKS. Quarterly Progress Report, September 1–November 30, 1964. (Rice Univ., Houston, Tex.). Contract W-7405-eng-26. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Effort was concentrated on a more detailed examination of the Conway granite cores with particular emphasis on the sites of the thorium and uranium. To locate these sites more exactly in core samples a different autoradiographic technique using fast x-ray film was put into operation. Although the Conway granite is markedly uniform, a very detailed megascopic examination of the cores found some slight mineralogical differences and evidence of hydrothermal activity in the lower part of Core "A." (auth)

11412 REMARKS ON THE OCCURRENCE AND ORIGIN OF THE URANIUM-BEARING SHALES OF THE MENILITE SERIES IN THE MIDDLE CARPATHIANS. M. Kita-Badak, J. Badak, and M. Saldan (Geological Inst., Warsaw). Bull. Acad. Polon. Sci. Ser. Sci. Geol. Geograph., 12: 71-7(1964).

Investigations carried out since 1956 have revealed the occurrence of U-bearing rocks at Bezmiechowa Gorna near Lesko (Poland). U-bearing shales were found also in the northern, middle (Sanok), and southern zone. In the northern zone are the U-bearing shales revealed at Jamna Dolna and Korzeniec near Bircza, Skopow near Krzywcza, Hyzne near Dynow, and Blazowa. The highest U mineralization was found in the middle (Sanok) zones, where the U content reached 620×10^{-4}%. The U-bearing shales belonging to this zone were found at Brzegi Dolne near Ustrzyki, Bezmiechowa Gorna and Monasterzec near Lesko, Wujskie and Tyrawa Solna near Sanok, Krosno and Kolaczyce near Jaslo. A chart represents the lithologic columns comprising the U-bearing shales of the Sanok zone, the diagrams for the shale-oil and U content and the γ radiation intensity. In the southern zone the presence of shales, exhibiting an increased radioactivity, was revealed at Krzywe and Habkowce near Baligrod. The U-bearing shales usually occur in the lower part of the menilite series. They are represented by black oil shales exhibiting a slaty or leaf-like cleavage. They are 0.5–5.0 m thick and probably form lenses several km long. The U content reaches 620×10^{-4}%, but it is much lower in the neighboring rocks. The bitumen content usually exceeds 4%. The correlation of the U content with the amount of bituminous substance was of a functional character. The U-bearing shales contain as a rule a larger bitumen content, but, on the other hand, not all the shales rich in bitumen substance are U-bearing. The U-rich shales of the menilite series occur in the form of layers, and their U content bears some relation to the bitumen substance. The U content was found to change gradually in a given horizon, both horizontally and vertically. Such a differentiation occurs in almost all the horizons. On the other hand, no dependence of the U mineralization on the tectonics or on depositional breaks was ascertained. This is suggestive of a syngenetic accumulation of U due to the adsorption by organic substances in the course of the bituminization process. Such a process may originate directly from marine water, which contains 1.0 to 1.8×10^{-6} g of U per liter. The U-bearing rocks occur in the part of the menilite series in the geanticlinal zones and also in the littoral zone. They form lenticular bodies in which the U is finely dispersed with the existing bituminous matter. The concentrations of U of syngenetic origin are probably due to the adsorption by the plankton and other organic substances in the course of bituminization. The reduction of U^{6+} to U^{4+} probably took place within the sediment. (BBB)

11413 ISPOL'ZOVANIE OREOLOV RASSEYANIYA URANA I ELEMENTOV-SPUTNIKOV PRI POISKAKH I RAZVEDKE GIDROTERMAL'NYKH URANOVYKH MESTOROZHDENII. (Use of Uranium Scattering Oreoles and Surrounding Minerals in Prospecting and Exploration of Hydrothermal Uranium Deposits). A. P. Solovov, ed. Moscow, Izdatel'stvo "Nedra," 1964. 194p.

Utilization of primary and secondary U scattering oreoles in prospecting and exploration for hydrothermal deposits is discussed and field assaying methods and techniques are described. Geochemical prospecting for the arc deposits and radiometric evaluation of U ores are also discussed. Extensive references are included. (R.V.J.)

HEALTH AND SAFETY

Refer also to abstracts 11039, 11305, 11341, 11394, 11500, 10719, and 12736.

11414 (AD-420472) RADIOLOGICAL TARGET ANALYSIS PROCEDURES. Ewald Ryll (Cornell Aeronautical Lab., Inc., Buffalo). June 28, 1963. Contract OCD-OS-62-207. 148p. (VP-1699-G-1). $11.50(OTS).

System aspects of large scale decontamination of populated areas were studied to determine optimal decontamination procedures for small-scale areas. Simple techniques demonstrated that a populated area of 700,000 people exposed to fallout from a 1 MT attack outside of the area can be restored in roughly 1 month. Analysis was conducted of scheduling the entry of operators into a radioactive field. Techniques similar to dynamic programming were applied, with the result that for certain circumstances specific optimal start times can be determined. Computational procedures and computer programs were evolved for testing procedures in simulated environments. Substantial analysis was performed on the shielding effect of structures in a target area. (auth)

11415 (CLOR-29) Z PRAC CENTRALNEGO LABORATORIUM OCHRONY RADIOLOGICZNEJ. (Reports of the Central Laboratory on Radiobiological Protection). J. Pensko (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centraine Laboratorium Ochrony Radiologicznej, Warsaw). 1964. 49p. Dep.

The laboratory (CLOR) was instituted in 1957 to investigate the exposure of the populace to radioactivity from natural and unnatural atmospheric and other sources, from activation of nuclei and from purchased quantities of radioisotopes; to regulate, control, and specify the proper shielding of radioisotopes being transported in Poland; to determine permitted levels of exposure for industrial and research workers and also for the general populace; to regulate the methods of dosimetry and prescribe normal practices of measuring sources and monitoring body exposures; to organize the teaching of personnel engaged in health physics throughout the country, and prescribe the safety practices in utilization of nuclear energy. These duties are described in detail. The growth of the organization, its work load and relative effectiveness since 1957 are given in concise, tabular form in this report. (TTT)

11416 (DPSPU-64-30-4) SAVANNAH RIVER PLANT BIOLOGICAL MONITORING PROGRAM. R. S. Harvey (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). May 1964. Contract AT(07-2)-1. 7p. (CONF-642-26). Dep.(mn); $1.00(cy), 1(mn).

From Health Physics Society, Cincinnati, June 1964.

Biological monitoring is an important part of environmental surveillance at an atomic energy plant because biota which may be in the food web of man take up and retain certain radionuclides. Each plant must adapt a monitoring program to suit the nature of its work and its environment. Initially at Savannah River Plant, a great variety of terrestrial and aquatic organisms, vegetation, and food crops were collected and analyzed for total alpha and beta content. More recently, certain indicator organisms (heterogeneous algae, bluegill sunfish, ring-necked ducks, and cottontail rabbits) have been selected and are being analyzed to estimate the trends of radionuclide uptake in the food web. (auth)

11417 (NP-14670) DATA FROM RADIATION PROTECTION PROGRAMS. VOLUME 2, NUMBER 12. (Canada. Dept. of National Health and Welfare, Radiation Protection Div., Ottawa). Dec. 1964. 87p. Dep.(mn).

In English and French.

Data are presented on the radioactivity due to fallout in samples of air, precipitation, and surface waters collected at various stations throughout Canada during Nov. 1964. Results are included on radioactivity in the environs of reactor sites, film monitoring of personnel exposed to γ sources or x radiation, and safety assessments of radioisotope users. Data are included on the content of ^{137}Cs in caribou, reindeer, and moose meat eaten by Eskimos and the ^{137}Cs content in Eskimo urine. Estimates were made of the ^{137}Cs body burden in Eskimos during 1964 based on the urine data. (C.H.)

11418 (NVO-162-12) KIWI-B4A REACTOR OPERATION. ON-SITE RADIOLOGICAL—SAFETY REPORT. Bernard F. Eubank and C. R. Penwell, comps. and eds. (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). Nov. 30, 1962. Contract AT(29-2)-162. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Fractured fuel material was ejected from the reactor during the operation of the KIWI-B4A rocket reactor. Approximately 18 acres of land around the test stand were contaminated by fission products in an uneven deposit of ejected material ranging in size from large, identifiable pieces to microscopic particles. Radiation levels greater than 500 R/hr were measured at near contact with the larger pieces one day after the reactor operation. On site radiological safety support activities are described. Radiation surveys of the test cell area and effluent cloud were determined to determine exposure hazards to personnel entering the test area soon after operation of the reactor. General support included issuing personnel-dosimetry devices and protective clothing and equipment, routine monitoring assistance, and decontamination services. Data are presented on radiation levels at various locations on the test area and a list is included of the portable radiation monitoring instruments used. Adhesive-coated trays at various locations were used for measurements of gross α and β activity. Decontamination activities included washing the road with high-pressure streams of water to remove contamination from the pavement and the location; recovery and transporting of identifiable pieces to the disassembly bay. A variety of tongs, long-handled shovels, 20-qt pails, and small Pb-lined boxes were used for handling and storing the collected radioactive material. A portion of the ejected material was located visually but most was obscured by vegetation and was located by the use of radiation survey instruments. (C.H.)

11419 (ORNL-P-745) RADIATION DOSE RECEIVED BY PASSENGERS AND CREW ON PLANES CARRYING RADIOISOTOPE SHIPMENTS. H. H. Abee and D. M. Davis (Oak Ridge National Lab., Tenn.). [1961]. Contract [W-7405-eng-26]. 11p. (CONF-803-5). Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Symposium on the Dosimetry of Irradiations from External Sources, Paris, Nov. 1964.

The transport of radioactive materials by commercial air carrier in the U. S. is governed by the Official Air Transport Restricted Articles Tariff No. 6C. Regulations that determine the rate of exposure from radioisotope shipments are reviewed. Results are reported from measurements of the exposure rate using 2 different isotope sources and 5 different aircraft of the types that normally transport isotopes. Measurements were also made on the exposure rate received by passengers while in transit from standard isotope packages containing ^{60}Co as a function of package load spacing. Radiation levels were also measured for the same passenger to source distance in open air. Results of these measurements showed that attenuation by the structural materials of the plane did not reduce the radiation dose by more than 15% for any measurement. The isotope packages were then arranged in various load spacings in open air with individual packages or groups of packages being spaced along a line simulating storage aboard a belly cargo compartment of an aircraft. Radiation exposure rates were measured at a distance equivalent to that specified in the current regulations as the minimum separation distance from personnel, and at other distances. A table of

separation distances between isotope packages or groups of packages was developed from the experimental measurements and calculations for practically all of the aircraft types used in the Southeastern U. S. It was concluded that regulations governing the transportation of radioactive materials by commercial air carriers need to be reviewed and updated, giving consideration to the long cargo spaces available on present commercial aircraft and the regulations governing the present maximum permissible radiation exposure rates established by national and international committees. (C.H.)

11420 (ORNL-P-856) RADIOISOTOPE SHIPPING CONTAINER DEVELOPMENT. K. W. Haff (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 8p. (CONF-641201-13). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Institute of Chemical Engineers Annual Meeting, Boston.

A low-cost fire and impact shield was developed for radioisotope shipping carriers weighing up to 1.25 tons. The shield is constructed of maple wood and a steel frame. The fire and structural tests that led to the final design are described together with the results. (D.L.C.)

11421 (RM-4238-TAB) FLOODS AND THE "POST-ATTACK BIOLOGY PROBLEM." A PRELIMINARY SURVEY. H. H. Mitchell (RAND Corp., Santa Monica, Calif.). Jan. 1965. Contract AT(04-3)-414. 30p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

Data are summarized on floods and flood damage in the United States. Health aspects of floods and human adjustments to floods are considered in the light of past experience. The possibility that devastating floods may be a consequence of the denudation of ground cover by fire and fallout following a nuclear attack is considered. An estimate is presented for the magnitude of flood problems during a post-attack period. (C.H.)

11422 (RSG-A-1) PRELIMINARY REPORT ON PUBLIC HEALTH HAZARD ANALYSES OF SPACE ISOTOPIC POWER SOURCES. J. J. Fitzgerald, Gordon L. Brownell, and N. Irving Sax—Jack J. Gabay, ed. (New York. State Dept. of Health, Albany). Mar. 1, 1964. Contract SAPH 76262. 87p.

A preliminary analysis was made of potential public health problems associated with the large quantities of radioisotopes required for space energy. The properties of likely radioisotopes are considered in some detail. A review was made of prospective NASA space missions to indicate extent to which specific isotopes may be used and the hazards associated therein. External and internal exposures from specific radioisotopes were calculated and specific credible incidents were evaluated. It was concluded that the planned space operations can be conducted at an acceptable level of safety if appropriate consideration is given to the selection of isotopes and if adequate safeguards are provided. Data are appended on the physical, chemical, radiological, and toxicological characteristics of space heat source materials including ^{90}Sr, ^{90}Y, ^{137}Cs, ^{144}Ce, ^{144}Pr, ^{147}Pm, ^{170}Tm, ^{171}Tm, ^{210}Po, ^{228}Th, ^{236}Pu, ^{238}Pu, ^{242}Cm, and ^{244}Cm; the bremsstrahlung production and spectra of ^{144}Ce and ^{170}Tm; and the pressure build-up from He release. (63 references.) (C.H.)

11423 (UCRL-12004) HAZARDS CONTROL QUARTERLY REPORT NO. 17, APRIL–JUNE 1964. (California. Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 41p. Dep.; $2.00(cy), 1(mn) OTS.

Calculations were made to predict the background counting rate in the proposed LRL whole-body counting room. A shadow shield whole-body counter was constructed and calibrated. Precise energy calibration of multichannel pulse height analyzer-NaI(Tl) systems allows the energy determination of an unknown gamma emitter to within ±0.5%. Thermal fogging, observed at low humidity, indicates that fogging effects are minimal below 50°C for exposure times of up to nine days in Du Pont 508 and 1290 films. A factor was found which corrects for the effects of angular dependence and fast neutron energy on the track per field dose of NTA film. A comparison was made under field survey conditions of four commercially available neutron survey instruments in various flux spectra and at various neutron flux levels. A portable calibration check point facility was devised to ascertain the calibration constancy of the Juno Model 3, the Jordan AGB-10KG-SR, and the Eberline E-500B survey meters. Tables of geometry factors for a uniform disk source coaxial with a totally absorbing disk detector are presented. Fire suppression operations were made more efficient by the use of a unitized package of water damage control equipment. The previously recommended tentative safe level of 10^{-7} J for integrated energy from a laser pulse entering the eye is reduced to 10^{-8} J and precautions are given for very fast pulses. (auth)

11424 (USNRDL-TR-801) A METHODOLOGY FOR STUDYING TARGET RESPONSE TO NUCLEAR ATTACK. W. Mostow, E. S. Shapiro, and S. H. Cassidy (Naval Radiological Defense Lab., San Francisco). Dec. 8, 1964. Contract AT(49-7)-2236. 41p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A methodology for studying the response of complex target systems to nuclear attack is presented. Targeting emphasis is on population, but the method may be adapted to treat other target systems such as agriculture and industry. Inputs include both attack and target system parameters; outputs include response to both prompt and delayed effects. A flow chart of the computer analysis system is given. (auth)

11425 CONTROL OF ISOLATION LOCKS IN NUCLEAR INSTALLATIONS. K. Peuster (Rheinisches-Westfaelisches Elektrizitatswerk AG, Essen). Atomwirtschaft, 8: 479-80 (Sept. 1963). (In German)

The control of isolation locks in nuclear installations must be arranged so that the greatest number of individuals can be saved in the event of a hypothetical disaster. The locks should consist of double doors that are operable by motors. The doors should be supplied with ventilating pressure locks that can be used for maintenance and control of differential pressures. The movement of the doors should be controlled by pushbuttons. They should not be controlled by circuit breakers, because personnel may forget to return them to the proper position. Pushbuttons should be provided to open, close, and hold the doors in a position. Doors should be operable from either side. In order to have control over traffic through the door the controls should provide for opening of the outer door or closing of the inner door from the outside. There should be some degree of precedence in the controls. This is least important for the controls located on the outside of the lock. The controls on the inside of the lock doors should be able to override the external controls. In turn, the controls in the lock should be able to override the controls on the inward side of the lock. However, the precedence of controls need not be absolute, and the control signals should be transmissible so that human judgement can be exercised for any given situation. There should be a single control point to or from which signals can be transmitted. Even if only a few signals can be devised and understood these could be some help in case of an accident. (BBB)

11426 THE RADIOACTIVE CONTAMINATION OF HUMAN BODY Sr^{90} AND Cs^{137} AND ITS CORRELATION WITH THE FALLOUT RATE AND GROUND DEPOSITION. Yasushi Nishiwaki (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Tech., Ser. B, No. 54, 115-29(Sept. 1963).

The results of the estimation of the radioactive contamination of human bone by strontium-90 as observed in Osaka district during the period from Jan. 1957 to July 1959 are introduced. Preliminary results of an animal experiment on the effect of calcium content in the diet on the deposition of radioactive strontium in rat bone are presented. The problem of contamination by cesium-137 is also discussed. An order of magnitude estimation of the approximate correlation between the radioactive contamination of the human body and the fallout rate and ground deposition of strontium-90 and cesium-137 is attempted.

The preliminary idea of permissible specific activity, which may be reasonable in restricting the environmental contamination, is suggested and discussed. (auth)

11427 THE METHOD OF DECONTAMINATION OF RADIOACTIVE SURFACE CONTAMINATION. (THE EFFECT OF SURFACTANTS AND CHELATING AGENTS). Yasushi Nishiwaki and Hajime Nishioka (Tokyo Inst. of Tech.). Bull. Tokyo Inst. of Tech., Ser. B, No. 54, 131-6(Sept. 1963).

For removing radioactive contaminants from various surfaces, an anionic and a nonanionic surfactant and chelating agents were used. The relations between the percent removal of surface contamination and the concentrations of the surfactants and those of the chelating agents were studied separately. The optimum concentrations of the surfactants and those of the chelating agents were estimated for the surfaces of glass, foliage, and cotton textile fabrics. The effects of combined use of the surfactants and the chelating agents were also examined. These combination agents were particularly effective for decontamination of some surfaces, for example cotton textile fabrics, which may be more or less porous. The decontamination agents with less harmful effects, which may be recommended for general use, are suggested. (auth)

11428 ELECTRON SLOWING-DOWN SPECTRUM IN WATER IRRADIATED BY GAMMA RAYS AND STRUCTURE OF ABSORBED DOSE. Nobuo Oda and Fumio Nishimura (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Tech., Ser. B, No. 54, 137-58(Sept. 1963).

A simple calculation method for the total electron slowing-down spectrum is described, taking into consideration δ production. Calculations were performed for ^{60}Co gamma rays and the resultant total electron spectrum (including δ rays) was applied to the LET distribution of the total electron flux. The spectral distribution of the absorbed dose is given as a function of the electron kinetic energy or the LET. Even with the cutoff energy of 1 kev for δ-rays, δ effects on the quantities obtained are remarkable. The meaning of the local energy loss is discussed in connection with the cluster formation and the statistical structure of the local absorbed dose in a small target is elucidated. The quantities such as the frequency distribution of clusters in the target and the effective flux for the cluster formation derived are of fundamental importance for the elucidation of the biological effect of gamma radiation. (auth)

11429 RADIOACTIVE SUBSTANCES IN INDUSTRIAL MEDIA. Docteur Jammet. Energie Nucl., 6: 371-8(Sept.-Oct. 1964). (In French)

The biological effects of radioactive substances, resulting either from external irradiation or from radioactive contamination, change according to the attained cells or tissues, and depend also on the period of irradiation. Methods of evaluating irradiation hazards and the bases for the Sanitary Standards fixing the maximum permissible doses are discussed. The rules to be respected in order to prevent accidents are indicated and the differences in toxicity existing between various radioactive substances are reviewed. (auth)

11430 THE CESIUM-137 CONTENT OF BEEF FROM DAIRY AND FEED-LOT CATTLE. Gerald M. Ward and James E. Johnson (Colorado State Univ., Fort Collins). Health Phys., 11: 95-100(Feb. 1965).

Samples of meat were collected from producing dairy cows, dry cows, young calves, and feed-lot fattened cattle and analyzed for ^{137}Cs, potassium, fat, and moisture. The diets, which were contaminated with varying levels of fallout ^{137}Cs, were analyzed to estimate daily intake of the nuclide. The ^{137}Cs levels per kg of edible meat leveled off at less than 1 percent of the daily intake in mature dairy cattle, at 3 per cent in feed-lot cattle and at 15 percent in calves. It is not clear whether differences are due to age or in the diet of the animals. The ratio of activity meat/milk per kg ranged from 1.2 to 4.9. It is estimated that the average consumer will obtain more ^{137}Cs from milk than beef, although under certain conditions the reverse could easily occur. (auth)

11431 DECONTAMINATION FOLLOWING A NUCLEAR EXCURSION. Ronald L. Kathren and John B. Huff (Univ. of California, Livermore). Health Phys., 11: 127-30(Feb. 1965). (UCRL-7781)

Unsophisticated decontamination methods successfully and economically reclaimed a large concrete vault highly contaminated by a nuclear excursion. The techniques used effectively decontaminated electronic apparatus and other equipment in most instances. In spite of initial alpha levels in excess of 10^6 dpm/100 cm^2, the operation was accomplished with minimal personnel exposure. No significant amounts of radioactivity were released to the environment. Thus, decontamination of large, highly contaminated areas may well be a feasible and practical course of action following a nuclear excursion. (auth)

11432 THE PERSONAL RETRIEVAL OF HEALTH PHYSICS INFORMATION. H. J. Dunster (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Health Phys., 11: 137-41(Feb. 1965).

The development of a hand-sorted punched-card information retrieval system for personal use is described. The system was developed for the retrieval of health physics data but could be used by persons working in any field. (C.H.)

11433 APPLICATION OF NUCLEAR ENERGY AND ITS EFFECTS ON THE PLANNING OF HOSPITALS. Hospital (London), 59: 143-58(Mar. 1963).

Planning for the incorporation of facilities for handling radioactive materials in the design of hospitals is discussed. Topics considered include the size and function of the facility and the availability of funds. Requirements and specifications are included for storage space, research labs, examination and treatment rooms, and waste disposal facilities for various types of hospital facilities. Safety and protection features are discussed. (BBB)

11434 INHALATION AND RETENTION OF FALLOUT ZIRCONIUM-95 BY HUMAN BEINGS. J. Rundo and D. Newton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 205: 37-40(Jan. 2, 1965).

The results of measurements of ^{95}Zr in human lungs in vivo up to Oct. 1963 and of attempts to correlate the levels observed with the amounts in the air breather are reported. After Oct. 1963 the effects of increasing whole-body contents of ^{137}Cs and decreasing lung contents of ^{95}Zr combined to make the estimates of the latter nuclide quite unreliable. It was concluded from the results, which are tabulated, that the ICRP model for the retention in the lung of small (< 1μ) particles underestimates the actual lung content by a factor of 2-3, and the biological half life of 120 days seems to be much too short. However, a reliable value for the biological half life was not determined. (P.C.H.)

11435 RADIOACTIVE RAIN, SNOW AND ATMOSPHERIC CONTAMINATION OBSERVED IN NAGAOKA CITY, JAPAN. REPORT IX. TOTAL INTENSITIES OF THE RADIOACTIVE FALLOUT DURING THE YEAR 1963. Ugoro Kobayashi and Hideho Sasaki (Niigata Univ., Japan). Niigata Daigaku Kogakubu Kenkyu Hokoku, No. 13, 1-13 (Mar. 1964). (In Japanese)

The artificial radioactivity of rain, snow, and airborne debris in Nagaoka city due to nuclear detonations was investigated in 1963. Owing to the interruption of atmospheric nuclear explosion tests in December, 1962, the radioactive fallout continued to diminish month by month although it increased somewhat in November and December of 1963 because of seasonal variation. (auth)

11436 ON RADIOACTIVE GIANT PARTICLES CONTAINED IN RADIATION FALLOUT. REPORT III. Ugoro Kobayashi and Hideho Sasaki (Niigata Univ., Japan). Niigata Daigaku Kogakubu Kenkyu Hokoku, No. 13, 15-24 (Mar. 1964). (In Japanese)

Gross contamination by giant particles was small compared with that by rain or airborne dusts in relation to a monthly total, but it was sometimes fairly large in relation to a daily total. The radioactive intensities of giant particles were approximately proportional to their volumes. Giant particles were divided into three broad classes ac-

cording to the values of the proportional coefficients. A gamma spectrum analysis was carried out. The density of giant particles was estimated at from 5.4 to 6.7 by sedimentation tests in water. (auth)

11437 EDUCATIONAL APPROACH TO RADIATION SAFETY IN A UNIVERSITY. Yasuo Yoshizawa and Emiko Sugimoto (Tokyo Univ.). Nippon Genshiryoku Gakkaishi, 6: 707-17(Dec. 1964). (In Japanese)

Education and training of radiation safety in universities is discussed. The radiation protection practices and education in some universities where undergraduate nuclear engineering courses are established were surveyed. (auth)

11438 NUCLEAR SAFETY. Volume 6, Number 1. William B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Fall 1964. $0.70(GPO) (domestic), $0.90(GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

Progress in nuclear safety is reviewed under the following sections: general safety criteria, accident analysis, control and instrumentation, plant safety features, consequences of activity release, and current events. Separate abstracts were prepared for each of the 19 topics covered. (M.C.G.)

For abstracts of individual items see: 10733, 11383, 11439, 11440, 11441, 11442, 11443, 11444, 11445, 11446, 11792, 11793, 11818, 12731, 12740, 12741, 12794, 12795, and 12858.

11439 RECOMMENDATIONS OF PUBLICATION 6 OF THE ICRP. Karl Z. Morgan. Nucl. Safety, 6: No. 1, 20-31 (1964).

Recommendations on radiological protection in the sixth ICRP report are summarized. Factors considered in the report are long-term effects, medical exposure of the population, medical exposure of women of reproductive age, exposure groups, short-term and emergency exposures, reduction of external exposure of employees with body burdens of radionuclides, area and volume to be considered when estimating dose, effects of dose rate, and eye exposure. Reduction of maximum permissible concentration (MPC) values for uranium, increase of MPC values for ^{90}Sr, and changes in MPC values for other isotopes are reported. (M.C.G.)

11440 RADIATION IN PERSPECTIVE. C. Rogers McCullough. Nucl. Safety, 6: No. 1, 31-7(1964).

The advantages to be gained, the penalties to be paid, and the risks to be taken in the development and use of atomic energy are discussed. The health effects of radiation and accident statistics are considered. (M.C.G.)

11441 IGNITION AND COMBUSTION OF FUELS AND STRUCTURAL METALS. Sigfred Peterson. Nucl. Safety, 6: No. 1, 41-5(1964).

Conditions for ignition and combustion of reactor materials are discussed. The theory of uranium ignition is outlined. Ignition of plutonium and Pu–U alloys is also considered. Studies of $Al-U_3O_8$ thermite reactions, low-temperature oxidation of uranium and plutonium, oxidation of other reactor fuels, and ignition of titanium are reviewed. Methods for safe handling of reactive materials are also considered. (M.C.G.)

11442 DIRECTIONAL GAMMA SENSOR FOR LOCATING THE SITE OF A NUCLEAR EXCURSION. H. Steinhauer, Jr. Nucl. Safety, 6: No. 1, 46-9(1964).

An economical directional gamma sensor is described, which satisfactorily located a source of gamma radiation during tests simulating, to a limited degree, a nuclear accident at a gaseous diffusion plant. Tests conducted using the sensor and survey meter in a radiation field showed that the instrument is capable of rapidly locating the specific criticality site if it occurs anywhere on the 220-acre floor area of the permanent buildings or anywhere else on the 4000-acre site of the Portsmouth Gaseous Diffusion Plant. (M.C.G.)

11443 POSSIBILITIES AND CONSEQUENCES OF MAJOR ACCIDENTS IN RADIOCHEMICAL PLANTS. C. E. Guthrie and J. P. Nichols. Nucl. Safety, 6: No. 1, 57-65(1964).

Operations likely to be undertaken by industry in the next decade in the fabrication of large isotopic power sources and in the production of reactor fuel from ^{239}Pu and ^{233}U were studied to determine the possibilities and consequences of major accidents. Results indicated that off-site economic losses could result from accidents in the radiochemical plants if the accidents caused the release of radioactive material, with consequent contamination of the environment and exposure of the public to radiation. The possibilities of such accidents and the potential economic losses were estimated by assumptions made relative to plant design, radioactive material inventory, population distribution, meteorological dispersion of radioactivity, and accident mechanisms. It was concluded that, with the containment and engineered safeguards included in a radiochemical plant, accidents having more than a theoretical possibility of occurring would not result in a monetary loss due to damage to the surroundings, which would exceed the limits of private insurance currently available ($60 million). (M.C.G.)

11444 FISSION-PRODUCT TRANSPORT. L. F. Parsly. Nucl. Safety, 6: No. 1, 65-9(1964).

Fission-product transport, especially behavior and control of radioiodine, was studied. Particle deposition and agglomeration and chemical forms of released iodine are discussed. (M.C.G.)

11445 SAFETY IN HOT-CELL DESIGN AND OPERATION. R. A. Robinson. Nucl. Safety, 6: No. 1, 72-7(1964).

Two factors were considered from a safety standpoint in the design and operation of a hot cell: the provision of adequate shielding against penetrating radiation and containment of radioactive materials within the cell. The performance of various shielding materials is described, and containment methods used are discussed. (M.C.G.)

11446 ENVIRONMENTAL SURVEYS FOLLOWING ACCIDENTAL RELEASES. H. H. Abee. Nucl. Safety, 6: No. 1, 87-9(1964).

The problem of environmental surveys following an accidental release of radioactive material from nuclear facilities is reviewed. Aerial survey techniques are described. The emergency environmental sampling program is discussed, and illustrated by the Sh-1 incident. (M.C.G.)

11447 EXPOSURE TO IONIZING RADIATION DETERMINED ON THE BASIS OF MEASUREMENTS OF INDIVIDUAL GAMMA DOSES DURING THE YEARS 1962–1963. Z. Baltrukiewicz. Polski Przeglad Radiol. i Med. Nuklearnej, 28: 595-601(Nov.-Dec. 1964). (In Polish)

Individual dose measurements were made at the Radiologic and Radiologic Protection Center during 1962 and 1963 on all persons having any occupational contact with ionizing radiation. The majority of the persons examined were luminous dial painters. Slightly higher doses were detected in 1963. Exposure exceeded the maximum permissible by 1.9% in 1962 and 3.1% in 1963. (H.M.G.)

11448 RESULTS OF MEASUREMENTS OF INDIVIDUAL DOSES IN THE WORKERS OF DIAGNOSTIC X-RAY INSTITUTES IN THE YEARS 1962–1963. Z. Baltrukiewicz. Polski Przeglad Radiol. i Med. Nuklearnej, 28: 607-11 (Nov.-Dec. 1964). (In Polish)

Results of measurements of individual radiation doses to personnel in laboratories and institutes using x radiation and that are regulated by the Ministry of National Defense and Home Office are presented. Dosimetry performed with films during 1962 and 1963 was determined in yearly and monthly increments. (H.M.G.)

11449 THE REMOVAL OF RADIO-ISOTOPE CONTAMINATION FROM SURFACES. D. G. Stevenson (United Kingdom Atomic Energy Authority, Aldermaston, Berks, Eng.). Proc. Congr. Intern. Federation Soc. Cosmetic Chemists, 2nd, London, 1962, 241-56(Pub.1963).

The contamination and decontamination systems appropriate to skin and hair treatment are studied. The appli-

cation of the principles evolved to practical decontamination is considered. (auth)

11450 RADIATION SAFETY: FALLOUT RATE MEASURED IN MILK. Glen B. Eich. Radiol. Technol., 35: 276-7(Jan. 1964).

Surveys are reviewed which show that ^{90}Sr in milk in the United States almost doubled in May 1963, compared with May 1962, as the fallout from last year's intense nuclear tests in the air returned to the earth. Increases in fallout from the stratosphere are coincidental with the arrival of spring, and were predicted. In June the nation's milk supply contained a daily level of 32 pC/l ^{90}Sr. Levels of ^{89}Sr, also created by fission explosions but of somewhat less concern than ^{90}Sr, rose significantly, too. However, both levels are considered far short of figures which cause concern or justify counter measures. The average daily intake of ^{131}I was 100 pC/day, or a 12-month total of 36,500 pC/year. The increases in May were not uniform, and in some cases the ^{90}Sr level decreased. In September ^{131}I counts averaged about 10 pC/l throughout the country. In the same month, ^{90}Sr varied from a high of 58 pC at a station in North Dakota to a low of 8 pC in Austin, Texas. (BBB)

11451 THE PROBLEM OF RADIOACTIVITY. Pietro Cignolini (Università, Palermo, Italy). Rass. Clin.-Sci. Ist. Biochim. Ital., 38: 111-16(Apr. 1962). (In Italian)

The extent and hazards of fallout radiation are discussed. (BBB)

11452 MEDICAL ASSISTANCE FOR WORKERS EXPOSED TO IONIZING RADIATION IN THE NUCLEAR INDUSTRY. G. Rombola and P. Magnanelli. Riv. Inf. Mal. Profess., 51: 167-74(1964). (In Italian)

The problem of preventing the risks connected with the industrial application of nuclear energy is discussed. The precautions adopted for the installation of plants and setting up work schedules are briefly illustrated. The norms used for protection and medical monitoring of workmen exposed to radiation are reviewed. Some particular problems regarding first-aid assistance to those exposed accidentally to massive radiation doses are discussed. (auth)

11453 LEAD ISOTOPES IN GASOLINE AND AEROSOLS OF LOS ANGELES BASIN, CALIFORNIA. Tsaihwa J. Chow and M. S. Johnstone (Scripps Institution of Oceanography, La Jolla, Calif.). Science, 147: 502-3(Jan. 29, 1965).

The isotopic composition of lead isolated from antiknock gasolines and the aerosols of the Los Angeles basin was determined. The lead isotopic composition of the aerosols was similar to that of rural snow. The high concentration of lead in water of precipitation and that of the surface of the sea is attributed to automobile exhausts. (auth)

11454 AN ENVIRONMENTAL SURVEILLANCE LABORATORY FOR RADIONUCLIDE ANALYSES. PART I. ESTABLISHMENT OF AN ENVIRONMENTAL SURVEILLANCE LABORATORY: A CASE STUDY. Edmond J. Baratta, Donald C. Parks, and Dade W. Moeller. PART II. ANALYSIS OF LARGE NUMBERS OF MILK SAMPLES FOR FISSION PRODUCTS. Marvin Rosenstein (Public Health Service, Washington, D. C.). Public Health Service Publication No. 999-RH-7. July 1964. 43p.

The planning, establishment, and operation of a Public Health Service laboratory for radiation measurement and surveillance are described. The facilities, personnel requirements, equipment, and analytical capacities of the laboratories are discussed. The techniques of handling large numbers of milk samples for analysis of fission-product activity are also discussed. Operational factors are considered, including intralaboratory quality control and time studies based on workload and laboratory capacity. (auth)

11455 PREVENTIVE MEASURES AGAINST RADIATION HAZARDS IN UNDERGROUND MINING. Vuchot, Berger, Duhamel, Pradel, Billard, and Granier. 16p. from "Third International Mining Congress, Salzburg, 15-21 September, 1963." [Geneva, International Labour Office, 1964].

Following a survey of the established units by which radiation doses are measured (absorbed dose, rad, rem), the following are discussed: the external and internal radiation to which workers in uranium mines are subject; radiation control regulations; protection against radon; the measurement of radioactivity; air pollution by uranium ore particles; and dust measurements and dust protection measures. A summary is given of the radiation protection regulations in France, which are administered by the French Radiation and Radiation Engineering Inspection Service. (Occupational Safety Health Abstr., 2: (1964))

11456 X-RAY EQUIPMENT SURVEY IN POLK COUNTY, FLORIDA, SEPTEMBER 1961–AUGUST 1963. Edgar F. Seagle (Public Health Service, Washington, D. C.). Sept. 1964. 92p. (Free) Public Health Service, Washington, D. C.

A field study of human patient exposure in x-ray diagnosis was conducted in Polk County, Fla. The study included physical surveys of 91.5 percent of diagnostic x-ray equipment in the county in use by all categories of practitioners of the healing arts. The methodology used is described in detail and discussed, along with the keeping of patient data records, measuring of attitudes towards keeping records, measuring of acceptance of recommendations, devising an improved means of communicating with the practitioner, limited measuring of radiation exposure reduction to the population, and transferring of findings to data processing cards. The report includes 35 tables of data, a series of 20 photographs depicting physical measurements, and copies of letters and forms used throughout the survey. (auth)

11457 RADIATION PROTECTION ASPECTS OF THE DESIGN AND OPERATION OF IRRADIATION FACILITIES. G. Saxon (Associated Electrical Industries Ltd., Manchester, Eng.). p.220-50 of "Radiation Sources." New York, The Macmillan Company, 1964.

Steps that need to be taken to ensure radiation safety in the design and operation of an irradiation facility are outlined. Legal aspects of work involving ionizing radiations are reviewed. The nature and distribution of radiation from radioisotope sources and from electron accelerators was studied, and the way it is absorbed in various shielding materials was examined. Data are given to enable shielding walls to be designed. The scattering of radiation along entrance corridors is also considered. The use of such data is illustrated by two designs of irradiation laboratories, one using ^{60}Co and the other an electron linear accelerator of the travelling-wave type. Special problems associated with linear accelerator installations are considered. Economic aspects of shielding are also discussed. (M.C.G.)

11458 ASPECTS OF OCCUPATIONAL AND ENVIRONMENTAL EXPOSURE TO IONIZING RADIATIONS IN SOUTH AFRICA. W. R. McMurray (Council for Scientific and Industrial Research, Pretoria). p.129-46 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Organized protection against radiation in South Africa is discussed. Included are methods used, population dose rates, and environmental radioactivity and radiation. Records have shown that where control has been adequate (and only the use of x radiation has not been subject to regulation), occupational exposure has been maintained at internationally acceptable levels. (P.C.H.)

11459 SURVEY OF BACKGROUND RADIOACTIVITY IN THE HARTBEESPOORT DAM. W. R. McMurray and L. Ottilie Stander (Council for Scientific and Industrial Research, Pretoria). p.147-58 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Samples of water, sediment, fish, plankton, and vegetation from the Hartbeespoort Dam were processed to reduce bulk, and the gross alpha- and beta-activity determined. The analytical methods used are discussed and the results are tabulated. The radioactive materials present in the

water, vegetation, plankton and fish were predominantly beta-emitting. The dam water contained approximately 0.01 pC/ml gross beta-activity; this, as well as the gross alpha-activity, was mainly in solution. (auth)

11460 THE RADON PROBLEM IN THE URANIUM-PRODUCING MINES OF SOUTH AFRICA. S. R. Rabson (Chamber of Mines Research Labs., Johannesburg), R. S. J. Du Toit, and C. J. Verwey. p.173-81 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

A general outline is given of the nature of the problem of radon in uranium mines. The investigations in progress for the measurement of radon and radon daughter concentrations in South African mines are described, and a description is given of the methods and instruments used. The results obtained to date are indicated in broad outline, and conclusions regarding the concentrations of radon and radon daughters are briefly discussed. (auth)

11461 RADON IN THE ATMOSPHERE OVER SOUTHERN AFRICA. W. R. McMurray (Council for Scientific and Industrial Research, Pretoria). p.182-91 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Routine S.A. Air Force flights across Southern Africa were used to obtain information on the horizontal and vertical distribution of radon in the atmosphere up to an altitude of 10,000 feet. The near-ground measurements fall within the range 2×10^{-14} to 7×10^{-14} Curies per liter. The effect of meteorological factors upon the atmospheric radon concentrations is illustrated by observations on the admixture of air coming in from over the Atlantic Ocean. The minimum radon concentration measured in such air was about 5×10^{-16} C/l. The average vertical profile of radon concentration is shown to determine a vertical diffusion coefficient of $\geq 3 \times 10^4$ cm^2/s relating to the mixing of the lower atmosphere in average weather conditions. This value of the vertical diffusion coefficient together with the average near-ground radon concentration gives a rate of injection from the land surface into the atmosphere of $(5 \pm 1) \times 10^{-10}$ Curies per square meter per hour. These results were obtained by application of diffusion equations, the derivation of which was outlined. (auth)

11462 A PROPOSED EMERGENCY NEUTRON DOSIMETRY SYSTEM. B. C. Winkler (Reactor Centrum Nederland, Petten, Netherlands). p.192-5 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

A neutron dosimetry system is described that is based on the foil activation method. The foils used are indium for immediate indication of exposed persons, gold and cadmium for measurement of the thermal or epithermal neutron flux, and a sulfur pellet for the fast neutron flux. These dosimeters are to be worn around the body. Measurement of the sodium-24 activity in the blood of exposed persons complements the foil measurements. Measurements would have to be made with human phantoms in order to arrive at the actual depth dose distributions, which could then be determined for exposed individuals. (auth)

11463 A REVIEW ON THE BIOPHYSICS OF NATURALLY OCCURRING RADIOELEMENTS IN THE AEROSOL. B. Rajewsky and J. Heyder (Max-Planck-Institut für Biophysik, Frankfurt am Main). 19p. (CONF-337-32)

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

A review is presented on the biophysics and correlation of aerosol particles carrying naturally occurring radioactivity and their biological efficiency. Information is included on: formation size and composition of particles of aerosols; origin of radioactivity in the atmosphere; distribution of radon and thoron and their daughter products in the atmosphere; particles of aerosols carrying naturally occurring radioactivity; storage time of naturally occurring radioelements in the atmosphere; the biological effect of particles of aerosol carrying natural radioactivity; internal burden by radiation; inhalation of radon and thoron; and inhalation of the descendants of radon and thoron. 62 references are included. (P.C.H.)

11464 RADIOISOTOPES AND REGULATIONS. J. C. F. MacDonald (Ontario Cancer Foundation). Toronto, Canadian Nuclear Assn., 1964, Preprint 64-CNA-130, 5p. (CONF-539-18)

From Canadian Nuclear Association Conference on Canada's Role in a World of Expanding Nuclear Industry, Toronto, May 1964.

The philosophy and some of the basic assumptions of radiological health, or radiation hygiene, is examined, especially as it applies to the use of radioisotopes in Canada. The discussion is in two phases: hazards associated with radiation that impinges upon the body from outside it; and internal radiation hazards from radioisotopes if ingested, inhaled, or absorbed through the skin. (P.C.H.)

11465 RECENT TRENDS IN OCCUPATIONAL RADIOLOGICAL HEALTH AND SAFETY. Robert L. Zimmerman (Georgia Inst. of Tech., Atlanta). 6p. (CONF-713-2)

From 4th Inter-American Conference on Toxicology and Occupational Medicine, Miami Beach, Fla., Aug. 1964.

Existing and suggested regulations in the use of radioactivity so that maximum utilization of radioactivity with adequate radiation control may be attained at a minimum cost are discussed. Difficult legal and financial complications can develop if all aspects of radiological health and safety are not considered. The areas to be thoroughly investigated include: compliance with applicable governmental regulations; legal implications; cost; insurance; staff; training; organizational status of radiological safety group; selection of proper instrumentation and equipment; radioactive waste management; employee relations; and public relations. (P.C.H.)

11466 PUBLIC HEALTH CONSIDERATIONS IN THE EVALUATION OF NUCLEAR FACILITIES. C. L. Weaver (Public Health Service, Washington, D. C.) and N. Gaeta. 9p. (CONF-642-21)

From Health Physics Society, Cincinnati, June 1964.

The duties and concerns of the Public Health Service in the evaluation of nuclear facilities are discussed. In accordance with an interagency agreement developed in 1961 between the AEC and PHS, the Division of Reactor Licensing of the Commission provides the PHS with copies of hazards summary reports and amendments thereto submitted by an applicant to the AEC. The PHS examines the reports from a public health viewpoint as a Federal health agency and also in its role of providing technical assistance to state agencies. This includes: evaluation of operating procedures in terms of existing standards; examination of the consequences of abnormal operation and of an MCA (maximum credible accident) on the surrounding environs; calculation of dose estimates to the population in the surrounding environs; and evaluation of effects of reconcentration of nuclides discharged to the environment. (P.C.H.)

11467 NEW DEVELOPMENTS IN CONTAINERS FOR SHIPPING RADIOACTIVE MATERIALS. J. A. Sisler and R. C. Gauerke (Sandia Corp., Albuquerque, N. Mex.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-6, 7p, $1.00. (CONF-763-20)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Because the consequences from an accidental release of radioactive materials are unknown, stringent requirements are imposed upon the construction of containers for the shipment of these items. The development of containers that meet these rather unusual requirements is discussed. (P.C.H.)

INSTRUMENTATION

General

Refer also to abstracts 11354 and 11363.

11468 (AD-604088) MILLIMETER WAVE GENERATION BY PLASMA. Final Engineering Report. (General Electric Co., Schenectady, N. Y. and General Electric Co. Heavy Military Electronics Dept., Syracuse, N. Y.). May 1964. Contract NObsr-89507. 83p. $3.00(OTS).

The feasibility of generating a radiating electromagnetic wave by the interaction of a velocity-modulated electron beam with a resonant plasma, and coupling this radiated energy directly into a waveguide or a coaxial line, is demonstrated experimentally. This experiment is based on theoretical studies of the interaction of space-charge waves with fully ionized resonant plasmas. A standard 9-Gc electron gun and helix configuration was utilized to produce and feed a velocity-modulated electron beam into a magnetically compressed, resonant plasma generated in mercury vapor. The work indicates that fast wave conversion will work best at the higher frequencies since the interaction length will be shorter and more probable of being achieved in a plasma. (auth)

11469 (AD-609638) THE DIOCOTRON INSTABILITY IN A CYLINDRICAL GEOMETRY. R. H. Levy (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Dec. 1964. Contract AF49(638)-659. 18p. OTS.

The diocotron (or slipping stream) instability of low density electron beams in crossed fields is considered for a cylindrical geometry. For a simple density distribution, the normal modes of the electron beam correspond to a continuum of eigenvalues, plus two discrete eigenvalues. The condition for stability considering the discrete modes only is derived; under suitable geometrical and electrical conditions, it is shown that these modes can be stable. The analogy between the electromagnetic problem considered and the problem of the stability of an ideal rotating fluid is discussed. It is shown that stability conditions derived for the latter problem depend on the possibility of axial perturbations; what this implies for the electron beam problem is briefly discussed. (auth)

11470 (ANL-6917) ON THE POSSIBILITIES FOR THERMAL NEUTRON IMAGE INTENSIFICATION. Harold Berger (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 19p. Dep.; $1.00(OTS).

Possible techniques and materials for a thermal neutron image intensifier are compared. A vacuum-tube type intensifier, in which an electron image is accelerated and demagnified within an evacuated envelope, appears to present a useful possibility for a neutron image intensifier. Neutron scintillators for use in such an intensifier are compared, and it is concluded that a lithium-containing phosphor, enriched in Li-6, could be used to provide an intensifier useful for thermal neutron intensities of 10^5n/cm^2-sec or higher. It is shown that such an intensifier would be capable of neutron image detection in the presence of an appreciable gamma-radiation background. (auth)

11471 (HW-75132) CONCEPTS OF INSTRUMENTATION RADIATION EFFECTS INSTRUMENT ENGINEERING. L. L. Azure (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 3, 1962. Contract AT(45-1)-1350. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Instrumentation concepts used for analyzing in-pile radiation effects on mechanical properties of materials are outlined. (T.F.H.)

11472 (HW-83447) PRTR WATER TREATMENT PLANT TURBIDITY MONITORING SYSTEM. F. H. Shadel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 10, 1964. Contract AT(45-1)-1350. 48p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The PRTR water treatment plant is a rapid sand filtration plant designed for semi-automatic operation. A turbidity monitoring system for use in the plant is described which provides continuous filtration of influent after alum addition and mixing, continuous sampling of water from each plant filter, and an alarm system for indicating high turbidity in any of the samples. The equipment and operation are described. (D.L.C.)

11473 (IPP-1/17) HOCHSPANNUNGSMESSUNG IN STOSSTROMANLAGEN UND IMPULSKREISEN. (High Potential Measurement in Collision Current Devices and Pulsed Loops). M. Ulrich (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Dec. 1963. 6p. Dep.(mn)

High voltage measurement heads were constructed for measurements in collision current devices and pulsed loops. The circuit, construction, and characteristics are given of an ohm high-voltage divider in differential hookup; a capacitive high-voltage divider in differential hookup; and capacitive high-voltage divider suitable for measurements of pulse voltages. (J.S.R.)

11474 (KFK-245) MODIFIZIERTES STEUERGERÄT ZUR DATENAUSGABE AUF LOCHSTREIFEN MITTELS TALLY-LOCHER 420 PR. (Modified Punch Control Unit with Two-Dimensional Scanning-System Operating Tally 420 PR). R. Hartenstein (Kernforschunsgzentrum, Karlsruhe, Germany). Aug. 1964. 26p. Dep.(mn).

The report is a supplement of the report KFK 201. In KFK 201 a control unit is described for scanning information of a great number of decades out of scalers or other data sources and operating a paper tape-punch unit. The control unit performs parallel-to-serial conversion by means of a "Two-dimensional" scanning system. The possibility of additional automatic typing out of data is discussed. The original version of the control unit described in KFK 201 is designed for operating a "Lorenz" punch unit (Type SL 614). This supplementary report shows the few changes of design which enables the unit to operate a Tally 420 PR punch unit. (auth)

11475 (NAA-SR-Memo-10366) RESISTIVITY MEASURING APPARATUS DESCRIPTION, OPERATION AND SAMPLE TEST RESULTS. Dennis Posey (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 19, 1964. Contract AT-11-1-GEN-8. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A system was designed for use in determining the resistivity of various low-resistivity metals vs temperature. These measurements are made under vacuum to prevent oxidation of the samples. Provision is also made for making measurements in a controlled hydrogen atmosphere. Temperature range is from ambient to 1000°C. An outline of the operational procedure is included along with a brief summary comparing test results of materials having known values of resistivity with manufacturers' values and handbook values. This comparison indicates that the system performs adequately. (auth)

11476 (NP-14660) ELECTRON TUBES RADIATION-RESISTANT PILOT-LINE PRODUCTION. Quarterly Progress Report No. 5, June 1–August 31, 1964. F. B. Parks and John Grimm (Tung-Sol Electric, Inc., Bloomfield, N. J.). Sept. 30, 1964. Contract DA-36-039-AMC-01476(E). 61p.

Production of 6080WB, 6360, and 6205 tubes in alumino-silicate glass stems and bulbs has continued. Additionally, 5886 tubes have been prepared by means of pinch press sealing. High temperature life testing (500°C bulb temperature) has continued on the 6080WB alumino-silicate tubes, eight having now successfully completed 500 hours of operation. Ten conventional glass 6360 tubes were high temperature life tested to destruction. The test then started on 6360 and 5886 tubes of alumino-silicate glass, and both are now continuing. The 1000 hours steady-state

nuclear radiation exposure test has commenced on representative samples of all four tube types in both conventional and alumino-silicate glass (40 tubes, total). (D.L.C.)

11477 (NUS-106) THE SIGNIFICANCE TO THE PHOTOGRAPHIC INDUSTRY OF RADIATION AND RADIOACTIVE MATERIALS IN THE ENVIRONMENT. C. Rogers McCullough, Morton I. Goldman, and G. Hoyt Whipple (Nuclear Utility Services, Inc., Washington, D. C.). Mar. 1962. For New York. Office of Atomic Development, Albany. Contract C-151333. 77p.

A review is presented of the effects of radiation and radioactive materials on the products and processes of the photographic industry and the history of such effects as a result of nuclear weapons testing programs and other sources of radioactive material in the environment. The protective measures taken by the industry to reduce damage from such sources are described. Although the industry maintained operations when atmospheric contamination from weapons fallout occasionally exceeded 70 $\mu\mu C/m^3$, the product was adversely affected in spite of expensive protective equipment and procedures. Insoluble particulates are especially troublesome and the industry has reported some film damage at the levels of less than 0.1 $\mu\mu C/m^3$ prevailing in mid-1961. The influence of nuclear installations on their environments is presented in the light of available experience. It is shown that (1) chemical reprocessing plants for spent nuclear fuels and large nuclear reactors possess a significant, but rarely exercised, potential for severe environmental radioactive contamination and (2) in two cases (one a severe accident, the other, normal operation) directly relating nuclear facilities to photographic manufacturing plants, no film damage can be attributed to the environmental contamination involved. Criteria for nuclear installations are presented which include recommendations for environmental radioactivity from peaceful uses of atomic energy in the vicinity of photographic manufacturing facilities. These recommendations are: (1) less than 10 mrad per year from gaseous material and (2) on the order of 0.1 $\mu\mu C/m^3$ of insoluble particulate matter suspended in air. It is concluded that, on the basis of available data, neither of these criteria should impose undue restrictions on properly located, designed, and operated nuclear installations. (auth)

11478 (NYO-2910-7) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 19, October 1–November 30, 1964. (Aeroprojects, Inc., West Chester, Penna.). Dec. 1964. Contract AT (30-1)-2910. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The molten salt level detector was received at Oak Ridge National Laboratory for tests in the molten salt loop. Temperature measurements up to 500°C using the acoustic phase-shift thermometer were made and the change in resonant frequency with temperature is reported. (auth)

11479 (SGAE-M-2/1964) ELEKTRONENMIKROSKOPISCHE DICKENBESTIMMUNG DUNNER EINKRISTALLAMELLEN. (Electron Microscopic Thickness Measurement of Thin Single Crystal Lamellae). E. M. Hoerl (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf). [1964]. 16p. Dep.(mn).

A method for thickness determination was described that depends on the dependence of the distance of the secondary radiation in the vicinity of the reciprocal lattice point on the thickness of the crystalline lamella. With it, absolute thickness measurements and relative measurements of the heights of crystalline stages can be made. It is generally easily carried out in relatively undistorted crystals and requires only a tipping of the crystal. (J.S.R.)

11480 A SIMPLE METHOD FOR THE MEASUREMENT OF MAGNETIC FIELD INDICES. J. Camplan and R. Meunier (Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, Orsay, France). Nucl. Instr. Methods, 31: 192-4(Dec. 11, 1964).

A simple and rapid method of measuring the magnetic field indices of inhomogeneous magnetic fields is described. It is based on the uniform translation of a large coil within the field region. The recorded emf allows a direct measure of the two first indices with an accuracy of 3 and 6% in the case described. The determination of shims can be done very rapidly with this device. (auth)

11481 A TRANSISTORIZED, FREQUENCY MODULATED PROTON MAGNETIC RESONANCE SYSTEM FOR THE MEASUREMENT AND CONTROL OF MAGNETIC FIELDS. W. C. Olsen (Univ. of Alberta, Edmonton, Can.). Nucl. Instr. Methods, 31: 237-44(Dec. 11, 1964).

A proton magnetic resonance system for the measurement and control of magnetic fields in the 1 to 13 kg range is described. It employs frequency modulation of the r-f oscillator rather than modulation of the magnetic field as in conventional systems. A d-c error signal of ±5 v for ±0.05 g change in field is produced for closed loop regulation of the magnet power supply. (auth)

11482 FAST GATE LOGIC FOR THE FUNCTION "AND." D. Maeder (Université, Geneva). Nucl. Instr. Methods, 31: 349-51(Dec. 11, 1964). (In French)

General specifications of the d-c coupled CLR/A series nanosecond logic modules and the abridged notation for the standardized input circuits (EE = étage d'entrée) and output circuits (ES = étage de sortie) are briefly recalled. Various possibilities of connections between three EE and one ES for constructing a three-fold AND gate are discussed. A simple configuration can be used in the slow mode. More elaborate circuitry is required for fast mode applications (2 ns fwhm, −0.7 v peak). Type CLR/A 527 twofold AND gate is based on a configuration in which clamping and limiting diodes are replaced by a low-value resistor and a transistor normally biased to cut-off. If this scheme is used with 3 EE's, adjustments tend to become critical. A third scheme is more complicated but easy to adjust, and allows extension to 4 EE's as in the CLR/A 502 quadrupole coincidence gate. Both normal and inverted outputs are available, and each output can drive at least two standard CLR/A inputs. Typical test oscillograms are given. (auth)

11483 STATISTICAL BEHAVIOUR OF SYSTEMS WITH VARIABLE DEAD-TIME. I. De Lotto (CISE, Milan) and P. F. Manfred. Nucl. Instr. Methods, 32: 175-6(Jan. 1965).

The output distribution of events of systems with variable deadtime is analyzed, for a Poissonian input distribution with given mean frequency. Cases of nonparalyzable and paralyzable deadtime are considered. Equations for the probability density function of the first event at the system output, the mean spacing between two output events and its variance, and the relative counting losses due to the system itself are derived. (M.J.T.)

11484 STEP GENERATOR WITH RISE TIME ≦150 PICOSEC. J. Oleson and P. W. Keaton, Jr. (Johns Hopkins Univ., Baltimore). Nucl. Instr. Methods, 32: 177(Jan. 1965).

A fast-risetime step generator was developed, using a tunnel diode to speed up the risetime of an existing square wave generator from 500 to less than 150 psec. The pulse generator circuit is presented, and the tunnel diode characteristics are given, with a description of the method of obtaining the desired bias current. (M.J.T.)

11485 ROUTINE MASS-THICKNESS AND NONUNIFORMITY DETERMINATIONS OF THIN FILMS. K. F. Wylie and G. R. Hagee (Mound Lab., Miamisburg, Ohio). Nucl. Instr. Methods, 32: 201-3(Feb. 1965).

A routine technique to rapidly determine the thickness and uniformity of thin plastic films and of thin plastic films coated with beryllium was developed. The thicknesses of Formvar films (approximately 20 to 100 $\mu g/cm^2$) and beryllium coated films (approximately 20 to 70 $\mu g/cm^2$ of beryllium) were determined using alpha particle attenuation techniques. Film thicknesses were determined by both alpha counting and destructive weighing. The difference between the two techniques was within the experimental error of 7.5%. (auth)

11486 THE ENERGY SPECTRUM OF ION BEAM EMITTED BY A PENNING-TYPE ION SOURCE. J. L.

Nagy (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Instr. Methods, 32: 229-34(Feb. 1965).

Measurements were made in continuous work on the energy spectra of ions emitted by low-power cold-cathode ion sources with longitudinal and transversal extraction applied. The ion energies were found to be invariably lower than the plate voltages. Surpassing 10% of the plate voltage, the energy spectrum is much wider than the few ev's expected. The increase in energy spread is due to the noise signals generated by the PIG discharges and to the detectable ion and electron oscillations. Finally, investigations were made on the composition of ion beam emitted by the source. (auth)

11487 A TRIPLE SUBNANOSECOND PULSE GENERATOR WITH AVALANCHE TRANSISTORS AND CHARGE-STORAGE DIODES. D. Ivekovic (Institut "Rudjer Boskovic," Zagreb). Nucl. Instr. Methods, 32: 339-40(Feb. 1965).

A composite pulse train generator is described. The circuit consists of three single pulse generator units, each of them using an avalanche transistor as a pulse generator and two charge storage diodes, the one as the leading and the other as the trailing edge shaper. The output pulse shape consists of three pulses spaced at time intervals variable in steps. The lowest value is 2 ns. The pulse train is of continuously variable amplitude, the highest available being 4 v on the 50 Ω load. The single pulse half-amplitude width is approximately 1 ns and the rise and fall-time less than 1 ns. These data were measured on a 0.6 ns rise-time sampling oscilloscope. (auth)

11488 CURRENT OPERATED NUCLEONIC MODULES. A. F. Arbel (Israel Inst. of Tech., Haifa). Nucl. Instr. Methods, 32: 341-6(Feb. 1965).

Current modules represent a unified approach to nucleonic instrumentation employed in low- and high-energy physics. The final system envisaged should be capable of replacing the presently used combination between readily available standard instruments and custom made special purpose circuits by a single line of instruments, whose use will shorten significantly the delay between the conception of a particular experiment and its execution. (auth)

11489 AN SCR FAST-LATCHING GATE CIRCUIT. H. Janzen and P. J. Scanlon (Queen's Univ., Kingston, Ont.). Nucl. Instr. Methods, 32: 353-4(Feb. 1965).

The design and operation of a fast-latching gate circuit are described. The basic gating elements are diodes and a silicon controlled rectifier. (C.E.S.)

11490 ELEKTRONNYE PRIBORY YADERNOI FIZIKI. IZDANIE VTOROE. (Electronic Instruments in Nuclear Physics. 2nd Edition). A. A. Sanin. Moscow, Izdatel'stvo "Nauka," 1964. 623p.

A survey was made of basic principles and construction of electronic devices used in nuclear physics. Linear electron installations, electron lamps, pulse amplifiers, linear amplifiers, amplifiers with small signal increments, and slow-changing voltage are discussed along with supply sources, amplifiers of weak currents, coincidence schemes, radiation detectors, and time analyzers. (413 references) (R.V.J.)

11491 METAL IDENTIFICATION METER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-615)

Five drawings are included. The extremely stable eddy-current instrument is used to sort metals and alloys on the basis of conductivity and permeability. It will positively identify Inconel parts in the presence of both the austenitic stainless steels and the Hastelloy, and it will identify a metal or alloy in any system of nonferromatic materials in which the conductivity of the metal is unique. It also is used to measure the thickness of thin metal sections. A battery power supply is used with the portable instrument. A circuit revision is included that reflects a change of some of the p-n-p type transistors to an n-p-n type. (P.C.H.)

11492 COMPARISON OF 21-103 ELECTROMETER AND ELECTRON MULTIPLIER SPECTRA. R. A. Meyer (North American Aviation Science Center, Thousand Oaks, Calif.). 9p. (CONF-649-24)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

Significant differences between the spectra obtained with the standard CEC electrometer (and Wein Filter) and those from the CEC 141820 electron multiplier have led to a wide range study. Spectral comparisons from the study are presented. (auth)

11493 EVALUATION AND APPLICATION OF AN IMPROVED SLIT PROBE FOR THE X-RAY SECONDARY EMISSION SPECTROMETER. Eugene P. Bertin (Radio Corp. of America, Harrison, N. J.). 33p. (CONF-715-5)

From 13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 1964.

One practical method for increasing the intensity obtained with small apertures is the use of a slit instead of a pinhole. It is limited to samples such as long linear inclusions; sections of coated surfaces, diffusion couples, and metal-to-metal and metal-to-ceramic interfaces; and other layered structures where composition varies in a direction normal to the layers, but not along any one layer. The slit also has several other disadvantages that do not apply to the pinhole. However, when used with samples of the proper type, the slit has two outstanding advantages: increased sensitivity and improved resolution. Moreover, the slit can be installed on a commercial x-ray spectrometer quickly and conveniently, and often allows useful x-ray probe work to be done on samples for which pinhole apertures would be inadequate. A slit probe has been improved and evaluated on a General Electric x-ray spectrometer equipped with a curved crystal. The improved accessory has been applied to studies of several metal-to-metal and metal-to-ceramic systems. These studies are discussed in detail. (D.L.C.)

11494 ELECTRON MULTIPLIERS FOR USE IN MASS SPECTROMETRY. B. R. F. Kendall (Nuclide Corp., State College, Penna.). 7p. (CONF-649-11)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

Factors influencing the design of electron multiplier particle detectors are reviewed. Experimental results are presented which show that, in addition to meeting the normal requirements of stable high gain with a low noise level, it is necessary in ultra-high-vacuum applications to minimize gas evolution effects caused by internal dynode resistor heating and by electron currents passing between successive dynodes. A brief description is given of the construction and performance of a small venetian-blind electron multiplier designed in accordance with these principles. The basic multiplier design is suitable for use in magnetic sector-field, quadrupole, time-of-flight, and other types of mass spectrometers. (auth)

11495 A COMPUTER PROGRAM FOR THE QUANTITATIVE INTERPRETATION OF MASS SPECTROGRAPH PLATES. Philip R. Kennicott. 35p. (CONF-649-23)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

The routine nature of the calculations required to quantitatively interpret a vacuum spark mass spectrograph plate suggests the use of a digital computer. A FORTRAN program is described which performs a large portion of these calculations. The option is provided of either constructing a curve from the input data by the two line method of Churchill, or of reading a separately constructed characteristic curve. The input data are corrected for the characteristic curve, for isotopic abundance, and for relative exposure. When more than one observation refers to a given element, the geometric mean of each observation, weighted according to isotopic abundance, is computed. The advantages of the program are threefold. First, the time required to quantitatively interpret a plate is substantially cut. Second, the accuracy of the photographic characteristic correction made by the computer has been found to be greater than the accuracy possible by hand methods. Finally, numerical data are now available describing the

characteristic curve for each photographic plate. These data are useful in comparing different emulsions and different developing techniques. (auth)

11496 INTEGRATOR USING A BLOCKING OSCILLATOR CIRCUIT. J. L. Engle (to U. S. Atomic Energy Commission). U. S. Patent 3,160,818. Dec. 8, 1964.

An electronic pulse integrator and a circuit for coupling the integrator output to a counter is described. Input pulses are integrated in a condenser and the output of the condenser is coupled to a counter through a blocking oscillator such that a predetermined charge on the condenser triggers the oscillator. (AEC)

Radiation Detection

Refer also to abstracts 11423, 11640, 12072, 12624, and 12746.

11497 (NYO-3421-1) PHOTOMULTIPLIER INVESTIGATION. Quarterly Report No. 1, June 15–September 15, 1964. H. M. Smith, R. Wasserman, and R. L. Rodgers (Radio Corp. of America. RCA Labs. Div., Princeton, N. J.). Sept. 29, 1964. Contract AT(30-1)-3421. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The relation between dark current pulses and afterpulses is investigated along with the problem of how both are affected by various parameters. Typical dark current pulse height spectra from photomultipliers show two classes of pulses. The variations in time intervals between multiplier pulses are discussed. A trigger circuit with variable delay and single sweep capabilities was designed and built. This circuit, used in conjunction with an oscilloscope, enables the photography of single photomultiplier pulse traces. A preliminary study of the increase of coincidences or multiple pulses was undertaken. The resolving time of the system is about 20 nsec. The tentative conclusion is that multiple type B electron pulses are truly large size pulses and not trains of pulses which occur with the resolving time of most analyzers. (N.W.R.)

11498 (TID-21446) DEVELOPMENT OF A HIGH-SENSITIVITY FAST NEUTRON DOSIMETER. Quarterly Report No. 6, August 1–October 31, 1964. B. H. Chase, R. R. F. Speers, J. M. Swartz, and M. O. Thurston (Phylatron Corp., Columbus, Ohio). Contract AT(11-1)-1226. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Diode processing studies were continued; plating of nickel (+boron) onto silicon and simultaneous diffusion of boron and phosphorus onto silicon were attempted. A comparison was made of the performance of different readout circuits. (D.L.C.)

11499 (UCRL-13128) PART I. FABRICATION PROCESS FOR HIGH-VOLTAGE PIN DETECTORS. PART II. APPENDIX. RESEARCH AND DEVELOPMENT ON FABRICATION OF PIN AND LID DETECTORS AND THE DRY RUN INTERFACE SYSTEM. (Solid State Radiations, Inc., Los Angeles). Sept. 1, 1964. For California. Univ., Livermore. Lawrence Radiation Lab. Contract W-7405-eng-48. 113p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Process specifications are given for the various operations involved in the manufacture of PIN gamma-transient detectors using boron-doped p-type silicon. Development work on the fabrication of lithium-ion-drift detectors for high sensitivity and of PIN detectors for high speed is reported. A dry run system for field testing detectors with simulated gamma-ray bursts is described, and some test results are given. (D.L.C.)

11500 (UJV-1179/64) THERMOLUMINESCENT DOSIMETRY—BIBLIOGRAPHY. Zd. Spurný (Československá Akademie Věd. Ustav Jaderného Výzkumu, Řež). [1964]. 13p. Dep.(mn).

A total of 144 references is presented to the literature on thermoluminescence, luminescence phenomena, and dosimetry of ionizing radiation. The period up to the first half of 1964 is covered. (D.L.C.)

11501 (ZfK-RN-24) SPALTKAMMERN KLEINER ABMESSUNGEN FUR REAKTORPHYSIKALISCHE MESSUNGEN. (Fission Chambers of Small Size for Reactor Physics Measurements). Rolf Schaelike (Deutsche Akademie der Wissenschaften, Berlin and Germany. Zentralinstitut fur Kernphysik, Dresden). Jan. 1964. 15p. Dep.(mn).

Miniature fission chambers as directly indicating detectors coated with uranium for measuring neutron fluxes in the Rossendorf annular-type Reactor were built. A detailed description of the construction of the chamber and of the technological problems are given. The chambers operate satisfactorily up to temperatures of 80°C. (auth)

11502 (AEC-tr-6227/3(p.173-82)) AN EXPERIMENTAL STUDY OF DIRECT MEASUREMENT OF ABSORBED DOSES IN LIQUIDS USING A SINGLE-BODY ISOTHERMAL CALORIMETER. B. Radak and M. Karapandzic. Translated from Bilten Inst. Nukl. Nauke "Boris Kidric," 15: 173-82(1964).

Exact direct measurement of the absorbed radiation energy in liquids using a single-body isothermal calorimeter consists of a series of measurements that make it possible to eliminate the energy absorbed in the walls. The apparatus on which conditions to be satisfied by the calorimetric body were investigated is described. Measurements of $G(Fe^{3+})$ and $G(-H_2C_2O_4)$ showed that conditions are found for reliable measurements. The disadvantages are pointed out. (auth)

11503 (ANL-Trans-115) THE EFFECT OF THE ENERGY SPECTRUM OF FAST ELECTRONS UPON THE DETERMINATION OF THE ABSOLUTE DOSE AFTER THE BRAGG-GRAY PRINCIPLE. B. Markus. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Biophysik, 1: 218-19(1964). 3p. Dep.(mn); $1.10(fs), $0.80 (mf) JCL.

An empirical correlation is established between the ionization dose and energy dose of electrons at 1 to 50 Mev, as measured by ionization chambers. (T.F.H.)

11504 AN APPARATUS FOR ESTIMATION OF THE RESOLUTION TIME OF COUNT SERIES WITH GEIGER-MUELLER COUNTERS. G. Moll (Hahn-Meitner Institut für Kernforschung, Berlin). Electron. Rundschau, 17: 176-8(Apr. 1963). (In German)

Transistorized equipment is described that was designed to be connected between a G-M counting tube and a scaler for measurement of resolution times. It does not affect the counting sensitivity of the instrumentation, and does not require any auxiliary equipment. Next to accumulation of counts, the major technical problem is to ascertain the minimum pulse interval. A maximum value can be derived from the minimum value. In this equipment, during the pulse interval, a condenser that was previously charged to a known value is discharged linearly with time, so that the residual charge, and thus the voltage, are measured for the length of the interval. The shorter the interval, the greater the residual voltage of the condenser. The potential is derived from a peak voltage rectifier whose output is used to charge the condenser. The value of the pulse interval is displayed on a meter. The instrument has the following input-output requirements: the input sensitivity is 50 mv; the measurement range for resolution times in this instrument is from 50 to 500 μsec, with a measurement error of ~15 μsec; and voltage requirements for the counting tube are 2000 v. The equipment is housed in a cabinet with dimensions of 235 × 165 × 145 mm. The circuit uses 31 transistors. (BBB)

11505 DETERMINATION OF RADIATION EXPOSURE FROM OVEREXPOSED $AgPO_3$ MICRODOSIMETER. Donald F. Logsdon, Jr., and David A. La Bar (USAF School of Aerospace Medicine, Brooks AFB, Tex.). Health Phys., 11: 131-3(Feb. 1965).

A limitation on the useful range of $AgPO_3$ glass dosimeters is the darkening effect produced by radiation doses above 8,000 R. A simple heat treatment was developed that extended the useful range of glass rod dosimeters read with the Bausch and Lomb reader in the 1000 to 80,000 R range. The glass rod dosimeter has a linear response, after the application of heat, below 1000 R, but because of the ease of measuring this dose region without heating, the method is not recommended for use with these lower doses. (C.H.)

11506 SATURATION OF DU PONT 508 FILM. Francis R. Holden and S. Russell Johns (Radiation Detection Co., Mountain View, Calif.). Health Phys., 11: 145(Feb. 1965).

Observations of the saturation of du Pont 508 films exposed to high-energy γ radiation or electrons indicated that saturation varies with developing conditions. (C.H.)

11507 NOTE ON THE MINIATURIZATION OF GEIGER COUNTERS. J. Kern (Universite, Freiburg i. B.). Intern. J. Appl. Radiation Isotopes, 15: 541-3(Sept. 1964). (In French)

Tests proving the feasibility of constructing G-M counters with an extremely low plateau slope were made on counters having a cathode diameter of 30 mm. These tests showed that with the suppression of boundary effects with guard electrodes, the utilization of an anode of predetermined diameter, and operation with a very pure mixture of argon and ethanol, the residual slope could be explained completely by the decrease of the dead time when irradiation was concentrated on the center of the counter. A study is made to see if these results can be extended to counters having a cathode of very different diameter. The effects to be considered are calculated, and the consequences of a unilateral reduction in the cathode diameter are determined. A solution is proposed to retain the desired characteristics and permit the miniaturization of the cathode diameter. (J.S.R.)

11508 A BREAK-DEAD TIME CIRCUIT FOR GM COUNTER TUBES. F. Leuteritz and M. Leistner (Institut fur Angewandte Radioaktivitat, Leipzig). Kernenergie, 7: 756-62(Nov. 1964). (In German)

An electronic device for GM counter tubes is described representing a combination between both break circuit and dead time circuit. The influence of the discharge effects of GM counter tubes was studied by using the counter tube VA-Z-112 from VEB Vakutronik WIB Dresden fitted with the break-dead time circuit. Especially it is shown that the counting losses due to the resolving time of the counter tube can be exactly determined also in the case of high counting rates. (auth)

11509 COMPARING INVESTIGATIONS ON GAMMA-RAY SURVEY INSTRUMENTS. W. Rossbander, H. Abel, and L. Wetzel (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Kernenergie, 7: 766-73(Nov. 1964). (In German)

An investigation of commercially available gamma-ray survey meters is reported. The following criteria were used to evaluate the instruments: 1) the detector sensitivity must be proportional to the "first collision" dose, 2) the error of protective measurements should not exceed 25%. These two criteria are analyzed and discussed. The method and procedure for measuring the deviation from proportionality and the directivity of various detectors are described; the VA-J-15 model was used as reference. The full-deflection ranges are tabulated and the total errors as function of the angle of incidence are plotted for eleven models. Twenty one references. (OTS)

11510 ICE CALORIMETER FOR MEASURING THE ABSORBED DOSE OF GAMMA-RADIATION. V. S. Grammatikati. Med. Radiol., 9: No. 9, 85-7(Sept. 1964). (In Russian)

Because of its low sensitivity and the complexity of the required instrumentation, the calorimetric method based on the determination of the heat generated by the absorption of the γ-radiation for measuring the dose, has not been widely used in the past. However, the method was found to be suitable for measuring the dose rate of the currently available powerful artificial radioactive sources in the 10^3 to 10^4 range/rad/min range and of the γ-radiation induced by charged-particle accelerators, because in these cases the lack of sensitivity is relatively unimportant. Ice was used as the tissue-equivalent absorber for determining the absorbed dose originating from ^{60}Co sources employed in radiobiological experiments. The types of apparatus built included an isothermal calorimeter which made it possible to determine total doses in the range from $2 \cdot 10^2$ to $7 \cdot 10^5$ rad of γ-radiation originating from 300 and 50,000 rad/min sources with an accuracy of 2 to 3%; an adiabatic calorimeter was also tested successfully. (TTT)

11511 COLLOQUE SUR L'UTILISATION DES DETECTEURS A SEMI-CONDUCTEURS EN PHYSIQUE NUCLEAIRE, UNIVERSITE DE LIEGE, 16-17-18 SEPTEMBRE 1963. (Conference on the Utilization of Semiconductor Detectors in Nuclear Physics, Liege, Belgium, September 16-18, 1963). L. Winand (ed). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 1-371(1964). (CONF-630904)

Separate abstracts are prepared for 27 of the 28 papers presented. An abstract of one paper previously appeared in NSA (18:41788). (C.E.S.)

For abstracts of individual papers see: 11205, 11512, 11513, 11514, 11515, 11516, 11517, 11518, 11519, 11520, 11521, 11522, 11523, 11524, 11525, 11526, 11527, 11528, 11529, 11530, 11531, 11532, 11533, 11534, 11535, 11610, and 12511.

11512 PRESENT ASPECTS OF DETECTION BY SEMICONDUCTORS. L. Koch (C.E.N., Saclay, France). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 11-21(1964). (In French)

The concepts that led to modern semiconductor detectors are briefly reviewed, and the essential properties of semiconductors are summarized. (J.S.R.)

11513 SURFACE-BARRIER DETECTORS FOR NUCLEAR RADIATION. A. Coche (Faculte des Sciences, Strasbourg). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 23-52 (1964). (In French)

The procedures for the preparation of improved Si and Ge surface-barrier detectors and their performance and characteristics are discussed. (J.S.R.)

11514 THE REVERSE CURRENT OF SILICON BARRIER RADIATION DETECTORS. W. K. Hofker. Mem. Soc. Roy. Sci. Liege, 10: No. 2, 53-66(1964).

In using barrier radiation detectors the reverse current is important because its noise contribution determines the ultimate resolution that can be attained. The reverse current of surface-barrier diodes as well as of diffused junctions is determined by bulk and surface properties. A discussion of measurements on oxide-protected silicon junctions and on gold surface barriers is given after a brief introduction to surface states. The current components of surface barriers are dealt with in more detail. (auth)

11515 LITHIUM-DIFFUSED DETECTORS. A. Garin (C.E.N., Saclay, France). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 67-81(1964). (In French)

The detectors obtained by compensation of the Si by the introduction of Li are discussed. The principle of the method is given. The preparation of a lithium-diffused detector involves the preparation of the Si base, development of an n zone by deposition of Li on one of the faces, migration of Li ions to create the intrinsic zone, establishment on another face of a contact electrode to reinforce the p zone, and mounting and measurement of the detector. Each of these steps is described. (J.S.R.)

11516 LARGE GOLD–SILICON SURFACE BARRIER DETECTORS FOR FISSION EXPERIMENTS. A. J. Deruytter, J. A. Moore, and I. G. Schroeder (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 83-93(1964).

Large gold–silicon surface-barrier detectors were constructed for the detection of fission fragments and energetic α particles (30 Mev). In the construction techniques, emphasis was put on the large surface, resolution, and sturdy construction. Careful surface treatment of the silicon wafer proved to be important for the final resolution. The use of delicate wires to make contact to the inversion layer was avoided. To illustrate the performance of the detectors, single fragment kinetic energy spectra and sum spectra ($E_1 + E_2$) were shown for the fission of ^{235}U with thermal neutrons. The performance for α-particle detection was also illustrated. (auth)

11517 DETECTION OF NUCLEAR RADIATION WITH THE AID OF LITHIUM-COMPENSATED DIODES, WITHOUT

INPUT WINDOW. P. Siffert, H. Rougeot, and A. Coche (Centre de Recherches Nucleaires, Strasbourg). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 95-104(1964). (In French)

Beginning with the classical techniques for the fabrication of lithium-compensated diodes, an apparatus, whose input window is equivalent to 30 kev or less (for 5-Mev α particles) was perfected by developing a surface-barrier diode on compensated silicon. The electric characteristics and the time stability, as well as the possibilities for the application of this detector to the spectrometry of heavy particles, electrons, and γ radiation, were indicated. (tr-auth)

11518 JUNCTIVE-BARRIER DETECTORS. G. Vallois (CEN, Saclay, France). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 105-13(1964). (In French)

The performance of energy loss detectors formed on the same platelet of Si by four large surface barriers and separated from each other by 80 microns was tested. The independence of each junction (possible influence by one junction on the other), extension of the sensitive zones, and variation of the resolution at the boundary of the zones separating the junctions was investigated. It was concluded that each junction was practically independent. The dead times were so narrow that they could not be shown. There was constant resolution over the entire surface of the junction. (J.S.R.)

11519 SURFACE-BARRIER NUCLEAR RADIATION DETECTORS WITH FAST RESPONSE. P. Siffert, H. Rougeot, and A. Coche (Centre de Recherches Nucleaires, Strasbourg). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 119-26 (1964). (In French)

Because of the utilization of surface-barrier detectors in fast electronic circuits, the form of the pulses (produced by ^{210}Po α particles) at the output of these devices was studied and the optimum conditions for a rapid response were determined. The electronic apparatus for pulse observation made it possible to measure rise times of less than 1 nsec when the signal amplitude was more than 2 mv. By the selection of a suitable thickness of the platelet constituting the diode and of the polarization applied, it was possible to attain rise times of less than 2 nsec even when the resistivity of the Si base exceeded $10^4\Omega$-cm. (tr-auth)

11520 ENSEMBLE FOR THE DETECTION OF CHARGED PARTICLES AT THE SACLAY CYCLOTRON. R. Chaminade and A. Falcoz (C.E.N., Saclay, France). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 155-99(1964). (In French)

The Saclay cyclotron was used to study the angular distribution of charged particles, to measure the asymmetry of angular distributions in scattering of polarized deuterons, and to study the proton-proton interaction in scattering of polarized protons on polarized protons. The detection apparatus common to all these types of experiments are described in some detail. (J.S.R.)

11521 MEASUREMENT APPARATUS FOR ALPHA SPECTROMETRY. R. Allemand and J. L. Lecomte. Mem. Soc. Roy. Sci. Liege, 10: No. 2, 201-9(1964). (In French)

The characteristics and performance of a measurement circuit adapted to semiconductor junction detectors (particularly in the area of α spectrometry) were studied. The transistorized measurement apparatus consists of a low-noise preamplifier and an amplifier stage. The theoretical aspects of the background noise in two versions of the preamplifier (the first with ordinary transistors and the second with transistors with field effect as input stage) were investigated. (J.S.R.)

11522 SHAPING OF p-i-n DETECTOR PULSES BY RC NETWORKS. C. A. J. Ammerlaan (Inst. for Nuclear Physics Research, Amsterdam). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 211-20(1964).

The results of pulse shape calculations for particles incident perpendicularly to the p-type surface of a lithium-drifted junction detector are presented. The nonlinearities introduced by shaping these pulses with a single RC integrator followed by a single RC differentiator are determined. The time constants of the networks are equal and have the same order of magnitude as the pulse rise time. (auth)

11523 TRANSISTORIZED PREAMPLIFIERS USED AT THE LABORATOIRE DE PHYSIQUE NUCLEAIRE D'ORSAY WITH SILICON JUNCTION DETECTORS. Guy Corbe (Faculte des Sciences, Orsay, France). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 221-9(1964). (In French)

Two types of transistorized preamplifiers were used with Si junction detectors, one with a resolution close to 15 kev and large dynamic capacity and the other with inferior characteristics but making possible a high counting rate and pulse durations less than 2×10^{-7} sec. The characteristics, design, and performance of each of these preamplifiers are described. (J.S.R.)

11524 PULSE HEIGHT DEFECT OF SURFACE BARRIER DETECTORS FOR FISSION FRAGMENTS. A. J. Deruytter (SCK-CEN, Mol, Belg.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 231-43(1964).

The pulse-height defect of large Au–Si surface-barrier detectors for fission fragments was evaluated. The average pulse height of the difference spectrum ($E_L - E_H$) was used as an absolute energy point. With this calibration the pulse-height defects of the average light and heavy fragment pulses and of the average sum pulse were determined. These measurements were made for the thermal neutron induced fission of ^{235}U. Also α particles from ^{234}U and from a Th source were used for calibration, and the resulting pulse-height defects for fission fragments were compared with the values obtained by the method previously described. The calibration of a detector by comparison of the measured pulse-height distribution to a standard fission fragment energy spectrum was shown for the thermal neutron induced fission of ^{235}U. The different parts of the pulse-height defect, i.e., window effect and true pulse-height defect of the junction, were discussed. The influence on the pulse-height defect of the supplementary absorption in the backing of two kinds of 4π targets made by electrospraying and by evaporation was illustrated. (auth)

11525 ON THE USE OF SEMI-CONDUCTOR COUNTERS IN THE INVESTIGATION OF RESONANCE REACTIONS. P. M. Endt (Rijksuniversiteit, Utrecht). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 245-54(1964).

The possibilities and limitations of semiconductor counters for the detection of protons and α particles, produced in reactions showing a resonant character, are discussed. The discussion is limited to the investigation of nuclides in the 2s-1d shell at bombarding energies below 3 Mev. The ground state transitions of (p,α) and (α,p) reactions and the elastic scattering of protons or α particles are considered. Studies being made on ^{22}Ne(p,p)^{22}Ne, ^{23}Na(p,α), ^{27}Al(p,α), ^{31}P(p,α), ^{19}F(α,p), and ^{31}P(α,p) reactions are discussed. (J.S.R.)

11526 A SOLID STATE DETECTOR TELESCOPE. W. Mausberg and E. Roessle (Institut fur Kernphysik, Frankfurt am Main). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 277-83(1964).

A detector telescope using only solid state detectors, some dE/dx and one E, and used to measure differential cross sections and angular distributions of the protons emitted by the reaction ^{28}Si(n,p)^{28}Al is described. The differences in energy loss, the pulse-height analysis of energies lost, and the efficiency of directional discrimination vs proton energy are shown. Distinctions can be made between opposite particle directions with the telescope. (J.S.R.)

11527 CHARACTERISTICS OF THE ELECTRONIC EQUIPMENT USED WITH SEMICONDUCTOR DETECTORS AT THE REACTOR STATION GEESTHACHT. H. J. Tauffenbach (Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 285-91(1964).

Two charge-sensitive preamplifiers for work with semiconductor detectors are described. One preamplifier follows a classical design. The other is a transistorized version for spectrometry of fast neutrons with LiF sandwich spectrometers. The circuit diagrams and noise contributions of the preamplifiers are given. (J.S.R.)

11528 USE OF DOPED SILICON JUNCTIONS IN HIGH-ENERGY PHYSICS. G. B. Collins, J. Menes, and J. Oostens (Brookhaven National Lab., Upton, N. Y.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 293-301(1964). (In French)

A 4.76-mm thick Li-doped Si crystal detector was tested in a beam of particles from the proton synchrotron. The beam, by the action of 2 magnets, furnished e, mesons (π) and (μ), p, and d of different momenta. The characteristics of the beam were determined by calibrating the magnets by the floating wire method to establish the trajectory of the charged particles in the magnetic field, then fixing other points from trajectory curves obtained by inserting increasing thicknesses of absorber in the beam and observing the disappearance of transmitted particles. The detector, in a Styrofoam box cooled by a rod which dipped into liquid N, was then placed in the path of the beam. A multichannel analyzer gave the pulse-height spectrum which showed peaks for the d, p, and particles of minimum ionization. The specific ionization value for each could be calculated from the position of the peaks. Plotting the number of the channel corresponding to the peak maximum against the specific ionization gave a straight line. The width of the peaks at mid-height showed an indeterminacy of ±10% on the ionization value of an individual particle. (C.E.S.)

11529 STUDY OF THE LOW-TEMPERATURE BEHAVIOR OF A LITHIUM-COMPENSATED SILICON JUNCTION. J. Heughebaert, G. Lemaitre, J. Oostens, and L. Van Gerven (Laboratoire des Hautes Energies, Brussels). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 303-6(1964). (In French)

The response of a Li-compensated Si junction having a surface of 20 mm^2 and 2.5 mm thickness to a ^{207}Bi source was investigated at the temperature of liquid air and below. A resolution of 25 kev was obtained at the temperature of liquid air. On a progressive lowering of the temperature to 58°K, no significant change was detected in the pulse spectra. But at the temperature of liquid hydrogen, the response became faulty. Reheating restored the response of the junction. (J.S.R.)

11530 ANNULAR DETECTOR FOR SPECTROMETRY AT 180 DEGREES. Gilbert Lemaitre. Mem. Soc. Roy. Sci. Liege, 10: No. 2, 307-10(1964). (In French)

The construction and characteristics of a surface-barrier annular detector of monocrystalline Si of the n type are described. (J.S.R.)

11531 ^{6}LiF SANDWICH SPECTROMETER MEASUREMENTS. J. Moritz (Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 311-16(1964).

Silicon surface-barrier detectors, having a LiF layer of 96% enriched ^{6}Li between them, are used. The sensitivity of the spectrometer is ~10^{-6} for n in the Mev region with LiF layers ~1 μ thick. Data are given for fast neutron spectra (1.0–6 Mev) measurements. Variations of the beam caused by polyethylene containing B and by graphite are shown. (C.E.S.)

11532 EXAMINATION OF THE POSSIBILITIES OF DIRECT METHODS OF SPECTRAL ANALYSIS OF INTERMEDIARY AND FAST NEUTRONS. C. Beets, Ph. Colle, H. Deckers, G. Gierts, and S. De Leeuw (CEN, Mol, Belg.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 317-40(1964). (In French)

The areas of validity of the spectral analysis of isotropic neutron populations were analyzed for ionographic-emulsion, proportional-counter, and junction-detector techniques in the case of (n,p) scattering and the $^{6}Li(n,t)^{4}He$ reaction. (J.S.R.)

11533 A SEMICONDUCTOR PROTON RECOIL TELESCOPE FOR NEUTRON SPECTRA AND FLUX DETERMINATION. P. H. White (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 341-9(1964).

Two silicon surface-barrier detectors were used to construct a proton recoil telescope for the measurement of neutron spectra and neutron flux in the energy range 3.5 to 14 Mev. Measurements made with the telescope were described and its performance was compared critically with a proton recoil telescope of conventional design. The factors affecting the resolution, accuracy, and energy range of the counter system were discussed. It was indicated that a telescope made with semiconductor crystals can, by careful design, be more versatile than one made with a proportional counter and CsI crystal. (auth)

11534 SPECTRAL ANALYSIS OF NEUTRONS BY THE REACTION $^{6}Li(n,t)^{4}He$, IN THE REGION BELOW 500 kev. G. Gierts (CEN, Mol, Belg.). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 351-5(1964). (In French)

A method for the spectral analysis of neutrons by the measurement of the triton energies of the $^{6}Li(n,t)^{4}He$ reaction is described. The spectrometer consists of two junctions face to face on the Li target. The efficiency of the technique was evaluated by an analysis of the neutron spectrum from a U block exposed to thermal neutrons. The advantages of this method were discussed. (J.S.R.)

11535 DEVELOPMENT AND FIRST APPLICATIONS OF A SEMI-CONDUCTOR DETECTION APPARATUS DESIGNED FOR MEDICAL AND BIOLOGICAL RESEARCH. R. V. Rechenmann and J. G. Swart. Mem. Soc. Roy. Sci. Liege, 10: No. 2, 357-69(1964). (In French)

A semiconductor detection device, using Si-base surface barriers, was constructed to test its utility in medical and biological research. The properties of the device were reported. The first applications were to the study of the translocation of elements in oat seedlings. The tracers ^{45}Ca and ^{22}Na were used. The semiconductor detector gave a true picture of the phenomenon: increase of the activity at the point measured, maximum, decrease to a plateau. A G-M counter measuring the same migration showed the effects of the slow increase of γ intensity around the counters. (J.S.R.)

11536 MEASUREMENT OF ABSORBED DOSES FROM ATOMIC BOMBS BY THERMOLUMINESCENCE. I. GLOW CURVES OF ROOF TILE SAMPLES IN HIROSHIMA AND NAGASAKI. Yoneta Ichikawa (Nara Gakugei Univ., Japan). N. Nara Gakugei Univ., 12: 51-7(Feb. 1964). (In Japanese)

A new method for dosimetry of atomic bomb radiation in Hiroshima and Nagasaki is presented. Roof tiles irradiated by the atomic bomb give off a glow called thermoluminescence. By measuring the glow intensity, the radiation dose of the bomb can be measured. The equivalent gamma dose of bomb radiation is obtained by comparing the bomb glow curve with the ^{60}Co gamma glow curve. The glow curve from bomb radiation in the past is different in shape from that of the ^{60}Co radiation at present. In general, the glow curve from ^{60}Co radiation has three peaks at about 150, 230, and 300°C. But the glow curve from past radiation was found to show no peak at about 150°C. This is due to decay at the normal temperature during the past 17 years. The glow curve resulting from the bomb radiation was classified into three types, the first of which does not decay at 230°C, the second decays partly at 230°C, and the third decays perfectly. The equivalent gamma doses were obtained from the sample of the first type. (auth)

11537 DETECTION OF LOW ENERGY ELECTRONS IN BETA-RAY SPECTROMETRY. Tokishi Kaminishi and Yoshiyuki Nakashima (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 13: 143-6(Apr. 1964). (In Japanese)

In-β spectrometry using a magnetic field, it is difficult to detect the low-energy electrons because of the absorption of the low-energy electrons by the window of the detector. The electron acceleration method was applied in order to avoid such trouble. In this study a CsI (Tl) scintillator was used as detector. The resolving power of the magnetic device was 2% for ^{137}Cs K-electrons. The front surface of the scintillator was spattered with Al to a thickness of about 1 $\mu g/cm^2$ and connected to an electric terminal in order to be used as an electrode. A d-c high voltage was applied for electron acceleration. The light output was fed to an ordinary single-channel spectrometer. The acceleration of electrons by the high voltage to the terminal was confirmed by the following observations: the appearance of

the lowest energy region in the recorded β spectrum, and the shifts of the pulse height distribution of various monoenergetic electrons. The scintillation and acceleration method was effective in detecting the low-energy electrons. The lower limit of the detectable energies was 11 kev. This will be improved by reducing the noise level of the measuring apparatus. (auth)

11538 A NEW BROAD RANGE SPECTROMETER WITH A UNIFORM-FIELD SECTORIAL MAGNET AND A PRECEDING QUADRUPOLE-MAGNET DOUBLET. K. Yagi (Tokyo Univ.). Nucl. Instr. Methods, 31: 173-88(Dec. 11, 1964).

Theoretical basis of constructing a high-resolution and high-transmission spectrometer of a broad range type for charged-particle nuclear reactions is given by the use of a uniform-field sectorial magnet and a preceding quadrupole-magnet doublet. Formulas for various ion-optical parameters in the spectrometer are obtained. The parameters are given as the explicit functions of fractional momentum changes over a range of ±10%. The spectrometer can analyze and detect particles over an energy range from E_{max} to 0.67 E_{max}. The application of a quadrupole-magnet doublet not only increases the solid angle but also improves the momentum resolution. A product-particle spectrometer is designed for the 55 Mev proton beam from the synchrocyclotron in the Institute for Nuclear Study. An energy resolution of 0.1% and a solid angle of 3×10^{-3} steradian can be obtained in the above mentioned energy range. (auth)

11539 FAST COINCIDENCE UNIT OF RESOLUTION VARIABLE FROM 1.5 TO 150 ns. Ch. Mantakas (Centre d'Etudes Nucleaires "Dimocritus," Athens). Nucl. Instr. Methods, 31: 189-91(Dec. 11, 1964). (In French)

A coincidence unit of 1.5 ns was achieved using printed circuit boards of fast tunnel diode discriminators and a time-to-pulse-height converter. The resolution can be varied from 1.5 to 150 ns by varying the threshold of one of the discriminators. A short description of the discriminators and the time-to-pulse-height converter is given. (auth)

11540 COINCIDENCE AND DISCRIMINATION CIRCUITS WITH TRANSISTORS AND TUNNEL DIODES. M. Banner and J. Teiger (CEN, Saclay, France). Nucl. Instr. Methods, 31: 205-12(Dec. 11, 1964). (In French)

The nonlinear properties of semiconductors are discussed. Examples are given for the use of the technique described in specific electronic circuits. (auth)

11541 STUDY OF DISTORTION IN NIKFI-R EMULSIONS. PART III. INFLUENCE OF HUMIDITY-TEMPERATURE TREATMENT ON THE IRRADIATION. I. Hauser (Zentralinstitut fur Kernforschung, Rossendorf), U. Krecker, and U. Krecker. Nucl. Instr. Methods, 31: 217-20(Dec. 11, 1964). (In German)

Before irradiation nuclear emulsions of type NIKFI-R were stored under different conditions of humidity and temperature in order to study effects of distortions and spurious scattering. As a result of this treatment the preferred direction of the distortion vectors is disturbed and their length is reduced. The shape of the curve of $\overline{D}_{ss}$ versus cell length is flattened. (auth)

11542 CALIBRATION AND PERFORMANCE OF A NEUTRON-TIME-OF-FLIGHT DETECTOR. J. B. Czirr (Univ. of Washington, Seattle), D. R. Nygren, and C. D. Zafiratos. Nucl. Instr. Methods, 31: 226-32(Dec. 11, 1964). (LA-DC-6567)

The properties of a neutron detector for time-of-flight studies in the Mev energy region are described; calibration techniques for obtaining the absolute efficiency vs energy relation are discussed and the results presented. The pulse-height response of several organic scintillators under neutron irradiation was measured and compared to the pulse height obtained from a gamma-ray source. (auth)

11543 PROPERTIES OF A RESONANCE SCINTILLATION COUNTER. L. Levy, L. Mitrani, and S. Ormandjiev (Sofia State Univ.). Nucl. Instr. Methods, 31: 233-6 (Dec. 11, 1964).

The properties of a scintillation detector, sensitive to resonance γ radiation, are described. The conversion electrons emitted after the absorption of γ radiation are used. For this purpose the target nuclei are included in a plastic scintillator. Experiments are made at room temperature with SnO_2. The relative difference between the recorded pulses with a moving source (also SnO_2) and without movement is 58% for the natural isotopic mixture and 130% for the one enriched to 64% ^{119}Sn. The measured line width Γ' is about 1.5 larger than the natural width of the transition Γ, as the absorber thickness is nearly zero. (auth)

11544 A SOLID STATE DETECTOR TELESCOPE WITH THE FACILITY OF DIRECTION DISTINCTION. W. Mausberg and E. Roessle (Universität, Frankfurt am Main). Nucl. Instr. Methods, 31: 245-9(Dec. 11, 1964).

A telescope for nuclear reaction studies consisting of a set of solid state detectors is described. By using at least two dE/dx detectors in addition to the E detector, it is possible to distinguish particles traversing the telescope in opposite directions. The properties and the performance of such a telescope were investigated. (auth)

11545 OVERLOADING ELIMINATOR FOR LINEAR AMPLIFIERS. C. Lasdaris and L. Papadopoulos (Nuclear Research Center "Democritus," Athens). Nucl. Instr. Methods, 31: 250-2(Dec. 11, 1964).

A transistorized system for linear amplifier overload protection is described. Protection is achieved by preventing pulses of excessive amplitude from entering the amplifier. (auth)

11546 A STUDY OF WEIGHING TECHNIQUES USED IN RADIONUCLIDE STANDARDIZATION. P. J. Campion, J. W. G. Dale, and A. Williams (National Physical Lab., Teddington, Middx., Eng.). Nucl. Instr. Methods, 31: 253-61(Dec. 11, 1964).

A critical examination is made of two source weighing techniques frequently used for radionuclide standardization, that in which the dispensing vessel is weighed before and after depositing a source and that in which the amount of liquid deposited on the mount is weighed directly. It is shown that, by careful attention to detail, agreement can be obtained between these two methods but that the first is to be preferred. (auth)

11547 A CHARGED PARTICLE IDENTIFICATION SYSTEM WITH BROAD ENERGY RANGE. L. W. Swenson (Franklin Inst., Swarthmore, Penna.). Nucl. Instr. Methods, 31: 269-78(Dec. 11, 1964).

A charged particle identification system is described which utilizes the EdE/dx product as computed by an analog multiplying circuit. The multiplier circuit permits compensation for the normal energy dependence of the EdE/dx product. The response of the system was measured for protons, deuterons, and alpha particles in the 2–18 Mev range using solid state E and dE/dx detectors. (auth)

11548 CORRELATION COUNTING OF COINCIDENT EVENTS. E. M. Friedlaender (Inst. of Atomic Physics, Bucharest). Nucl. Instr. Methods, 31: 293-300(Dec. 11, 1964).

A statistical analysis is made of the correlation method for estimating the mean number of coincident events in electronic or visual counting. Statistical errors and their significance levels are deduced. Biases arising from spurious correlations or from imperfect timing are discussed, and methods for their detection and elimination proposed. A new method for estimating radioactive decay constants is pointed out. (auth)

11549 TECHNIQUES FOR THE FABRICATION OF LITHIUM DRIFTED GERMANIUM GAMMA DETECTORS. W. L. Hansen and B. V. Jarrett (Univ. of California, Berkeley). Nucl. Instr. Methods, 31: 301-6(Dec. 11, 1964). (UCRL-11589)

Many new problems are encountered in attempting to

apply silicon lithium-drifting technology to germanium. Lithium is much more mobile in germanium and its equilibrium solubility at room temperature can be less than the acceptor concentration. The low intrinsic temperature requires drifting at low temperatures and large currents which is frustrated by the lower thermal conductivity of germanium. Large crystals of germanium are also very fragile and are easily damaged by thermal or mechanical shock. However, developed techniques permitted the manufacture of a large number of detectors with depletion depths to 1 cm, depleted volumes to 7 cm^3, and energy resolution on 100 kev γ's to 2.1 kev fwhm. These techniques are described, and some results obtained using the detectors are presented. (auth)

11550 RESOLUTION CORRECTION FOR AN IDEAL MAGNETIC BETA-SPECTROMETER. H. Paul (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Seibersdorf, Austria). Nucl. Instr. Methods, 31: 307-13 (Dec. 11, 1964).

An ideal spectrometer (i.e., a spectrometer free of scattering in which the shape of the magnetic field is independent of the field magnitude) has a universal response function, constant transmission, and a linear calibration curve. By defining the spectrum shape factor in a slightly unconventional way, the distortion of a continuous spectrum N due to finite resolution can be rigorously expressed by a correction factor C. C is given by an integral, but it can also be expanded into a sum over the moments of the response function, which has the derivatives of N as coefficients. Numerical results are given, in particular, for Gaussian response functions, and it is shown that these are applicable to other shapes also. The results are different from those of Owen and Primakoff. (auth)

11551 ON MEASUREMENTS OF DISINTEGRATION RATES OF RADIOACTIVE SOURCES BY COINCIDENCE METHODS. I. S. Panasyuk (Kurchatov Inst. for Atomic Energy, Moscow). Nucl. Instr. Methods, 31: 314-16 (Dec. 11, 1964).

First steps were made in the theoretical study of the effect of the spatial distribution of the active-atom density and of the self-absorption of radiated particles inside radioactive sources on the shape of theoretical formulas for computing absolute source activities using the coincidence method. (auth)

11552 EFFICIENCY OF IONIZATION MEASUREMENTS IN NUCLEAR EMULSIONS. J. Cohen (Inst. of Atomic Physics, Bucharest). Nucl. Instr. Methods, 31: 317-21(Dec. 11, 1964).

To estimate the number of gaps and the detection efficiencies of ionization measurements in nuclear emulsions, it is suggested to use the double scan method in addition to the correlation method to obtain an estimate for the number of gaps coinciding in two successive scans, without having these gaps identified. The efficiencies obtained on tracks of different densities turned out to be different, thus proving the dependence of the detection efficiencies on the average gap density and hence the fact that the information contained in the track is nonhomogeneous with respect to the detection efficiency. The normalized gap density depends only weakly on the observer but shows significant differences with respect to the value obtained after correcting for scanning inefficiencies. (auth)

11553 AN AUTOMATIC GAIN STABILIZER FOR SCINTILLATION COUNTERS. J. L. Black and E. Valentine (Oxford Univ.). Nucl. Instr. Methods, 31: 325-8 (Dec. 11, 1964).

A gain stabilizer for use with scintillation counters is described. The system is very useful in high energy (to 40 Mev) gamma spectroscopy using large NaI(Tl) counters. The long term stability is better than one part in 200, and the system will automatically stabilize against gain changes of ±50% with a stabilization factor of 75. (auth)

11554 NON-PERIODIC HIGH SPEED PULSERS. R. F. Rumphorst (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Instr. Methods, 31: 329-32(Dec. 11, 1964).

Two pulse generators utilizing the negative resistance of zener diodes in a relaxation circuit are described. It is shown that the near randomness and average rates to 10^7 pulses per second make these pulsers especially suitable for testing nuclear electrons. (auth)

11555 COMPACT SOLID STATE HIGH VOLTAGE SUPPLY. E. M. Sheen and C. A. Ratcliffe (General Electric Co., Richland, Wash.). Nucl. Instr. Methods, 31: 339-40(Dec. 11, 1964). (HW-SA-3466)

A compact, electronically-regulated, solid-state high voltage supply was developed for use in scintillation spectrometry applications. Miniature transformers were used to minimize the weight, and a voltage range from 600 to 1500 d-c at 0.25 mamp was provided with a voltage temperature coefficient of 0.01%. (auth)

11556 A SELF-TRIGGERING SPARK CHAMBER. S. Yasumi, H. Itoh, A. Masaike, and K. Miyake (Kyoto Univ.). Nucl. Instr. Methods, 31: 343-4(Dec. 11, 1964).

A mole of spark chamber operation is described, in which a spark chamber is operated by triggering with the scintillation pulse produced in the chamber gas itself by the passage of ionizing particles. A schematic diagram of the self-triggering spark chamber is given. The operation of a photomultiplier-protecting circuit, which uses the same pulses as the spark-chamber voltage pulsing circuit, is described. (M.J.T.)

11557 STATISTICAL PROBLEM IN PULSE SHAPE DISCRIMINATION TECHNIQUE. Y. Takami and M. Hosoe (Rikkyo Univ., Tokyo). Nucl. Instr. Methods, 31: 347-8 (Dec. 11, 1964).

In the pulse-shape discrimination technique, the difference between the slow components of proton and electron scintillations is used to distinguish proton from gamma pulses. The proton counting efficiency was calculated by a formula for the decay of the slow component and compared with experimental results using a stilbene scintillator and a differentiator RC network. (M.J.T.)

11558 TWO-DIMENSIONAL TIME ANALYZER SUITABLE FOR LIFE-TIME MEASUREMENTS IN THE NANOSECOND RANGE. M. Bonitz, P. Winkler, and R. Kaestner (Deutsche Akademie der Wissenschaften, Berlin and Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Nucl. Instr. Methods, 31: 357-9(Dec. 11, 1964).

A method of simultaneously identifying the lifetime values of all energy levels of a nucleus for a definite energy and lifetime range using a two-dimensional time analyzer is presented. The block diagram of the test arrangement is given. Sample time spectra of ^{56}Mn and ^{60}Co are pictured. Advantages of the two-dimensional, 2048 channel analyzer are discussed. (M.J.T.)

11559 A LOGARITHMIC CONVERTER FOR NUCLEAR PULSES. T. Hiramoto (National Inst. of Radiological Sciences, Chiba, Japan). Nucl. Instr. Methods, 32: 141-6(Jan. 1965).

A logarithmic converter is described which provides a means of adapting a regular linear amplifier to logarithmic operations. The converter basically consists of a current generator and a log-take element. To stabilize the static reference level and to obtain a wide logarithmic range, a method of polarizing the conversion diode is proposed. Operational characteristics, pulse response, and the effect of variations in temperature are discussed. (auth)

11560 TRANSISTOR BIASED AMPLIFIER UTILIZING CURRENT SWITCHING TECHNIQUES. R. N. Larsen (Argonne National Lab., Ill.). Nucl. Instr. Methods, 32: 147-51 (Jan. 1965).

The transistor circuit described amplifies linearly the portion of a pulse above a selected bias level. The circuit utilizes a series-parallel diode current switching scheme to overcome many of the problems involved in the more common voltage switching circuits. It is entirely direct coupled to reduce overload and count-rate distortions. The bias temperature stability is 0.005% of full scale per degree C. The differential nonlinearity of the output is better than ±1%, independent of bias level. (auth)

11561 INTERNAL CONVERSION SPECTROMETER USING A SEMICONDUCTOR DETECTOR. R. C. Catura (Univ. of California, Los Angeles). Nucl. Instr. Methods, 32: 152-6(Jan. 1965).

A spectrometer is described for investigating spectra of electrons from internal conversion following positron decay. It is designed to study a broad range of electron momenta in a small amount of time for ease in investigating short lived activities. The instrument's operating characteristics are described, and measurements made on the decay of ^{106}In are presented. (auth)

11562 RESEARCH ON THE SCATTERING AND THE STIGMATISM FOR A MAGNETIC SPECTROGRAPH USING A SYMMETRIC FIELD OF REVOLUTION r^{-1}. J. Riche (Université, Lyon). Nucl. Instr. Methods, 32: 157-62(Jan. 1965). (In French)

The focusing properties of a trochoidal spectrograph with a magnetic field proportional to 1/r were studied to a first approximation. The calculations yield a certain number of optimum values for the parameter $k = r_0H_0/pH$. Different applications are considered: a more detailed investigation for k = 2 showed that excellent luminosity and resolution can be obtained. Construction of a smaller instrument (k = 3.2) is in progress. (auth)

11563 GEOMETRICAL OPTIMIZATION OF INTERACTION VERTICES IN SPARK CHAMBER ANALYSIS. B. Zacharov (CERN, Geneva). Nucl. Instr. Methods, 32: 163-7 (Jan. 1965).

In spark chamber experiments, where there is difficulty in measuring directly the interaction vertices of multiprong events, use can be made of over-determination in linear track measurements to determine the best values of vertex coordinates. The method used is that of least-squares fit with constraints. An iterative procedure is used and the appropriate expressions for improving the fit at each stage are developed together with the error matrix for the fitted variables; means of generating the starting values are also discussed. The flow diagram for a computer program, VTXFTN, performing the fit for a variable number of measurements, is given, as well as the detailed coding, in FORTRAN, for forming the residuals and derivative matrices. (auth)

11564 TUNNEL DIODE TIME MARKER CIRCUIT FOR USE WITH SCINTILLATION COUNTERS. R. N. Larsen (Argonne National Lab., Ill.) and E. B. Shera. Nucl. Instr. Methods, 32: 168-70(Jan. 1965).

A tunnel diode time marker circuit for use with scintillation counters is presented. The primary advantage of the circuit is its simplicity. Sufficient sensitivity is available to permit use of the circuit with moderate gain photomultipliers. The output timing signal is a high level pulse and can be fed directly to fast coincidence or time-to-pulse height circuitry. Results obtained with the circuit are described, and some considerations concerning construction are discussed. (auth)

11565 FLAT RESPONSE TO NEUTRONS BETWEEN 20 kev AND 14 Mev OF A BF_3 COUNTER IN A SPHERICAL HOLLOW MODERATOR. M. Ladu, M. Pelliccioni, and E. Rotondi (CNEN, Frascati, Italy). Nucl. Instr. Methods, 32: 173-4(Jan. 1965).

The response of a BF_3 proportional counter in a paraffin spherical hollow moderator was studied for AmBe (2.6×10^6 n/sec) and SbBe (0.9×10^6 n/sec) sources. The angular response uniformity was verified, and the sensitivity was determined. Sensitivity vs neutron energy from 20 kev to 14 Mev is presented. (M.J.T.)

11566 RESOLUTION AND LUMINOSITY OF A TRIPLE AXIS CRYSTAL SPECTROMETER IN EXPERIMENTS OF ELASTIC NEUTRON DIFFRACTION. G. Caglioti and D. Tocchetti (Comitato Nazionale per l'Energia Nucleare, C.C.R. Euratom, Ispra, Italy). Nucl. Instr. Methods, 32: 181-9(Feb. 1965).

The geometrical features of an experiment of elastic neutron diffraction by means of a triple axis crystal spectrometer are discussed. General formulas for the instrumental luminosity and resolution are given in terms of the angular divergences of the collimators, the mosaic spread of the crystals, and the values of the wavelength dispersion parameters. The focusing properties of the triple axis spectrometer and the possible left-right arrangements of its arms are briefly considered. The advantages of the elastic diffraction for improving the resolution, reducing the effects of the second order wavelength contamination of the monochromatic beam and controlling the thermal diffuse intensity are shown. Finally, experimental tests of the theoretical results are presented. (auth)

11567 LOW-ENERGY GAMMA-RAY SPECTROSCOPY USING AN X-RAY-ESCAPE GATED PROPORTIONAL COUNTER. P. G. Hansen, H. L. Nielsen, E. T. Williams, and K. Wilsky (Research Establishment, Riso, Denmark). Nucl. Instr. Methods, 32: 197-200(Feb. 1965).

The utility of a gas-filled proportional counter in low-energy γ spectroscopy is greatly increased if it is operated in coincidence with an escaping fluorescent x ray. An apparatus, having an efficiency greater than 10% of singles, is described, and several examples are given. An efficiency curve is presented. (auth)

11568 A NEW METHOD OF UTILIZATION OF NaI(Tl) CRYSTALS IN THE DETECTION OF HIGH-ENERGY GAMMA RAYS. M. De Abreau and H. Nifenecker (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instr. Methods, 32: 204-9(Feb. 1965). (In French)

The detection of high-energy gamma rays (E > 2 Mev) with NaI(Tl) crystals gives a very complex answer due to the fact that one or two gamma rays of 511 kev, from pair production, or the primary gamma ray, after Compton scattering, can escape from the crystal. If one observes only the gamma rays that lose a great part of their energy in the central region of the crystal, assuming that the partial interactions take place essentially near the surface, one will detect only gamma rays losing their whole energy in the crystal. Theoretical considerations about the conditions of work, shape of the spectrum, and efficiency are presented with the experimental data. (auth)

11569 DECISION-MAKING SPARK CHAMBERS. Ch. Rey, S. Parker, B. Sherwood, and D. Schwartz (Univ. of Chicago). Nucl. Instr. Methods, 32: 217-23(Feb. 1965).

A wire spark chamber system was developed in which information can be analyzed within 30 to 50 nsec of the spark time and used to trigger other spark chambers for a more detailed analysis of the same event. The wire chamber system has good spatial resolution, very low mass, a recovery time of less than 1 msec and a fast, low impedance output capable of driving versatile core arrays. By running the wires in simple patterns through core arrays, it is possible to get signals whose pulse height is proportional to such things as the number with more than some minimum separation, the position of a spark, and the separation of two sparks. Many other kinds of spatial decisions can be made with these devices such as the recognition of scattering of a particle and coplanarity of two particles. Such decision-making spark chambers were used to trigger an optical spark chamber on two track events. Wires were grouped together at the outputs to give 1 cm spatial resolution. The observed single track efficiency for one gap was greater than 99% and the double track efficiency was greater than 97%. (auth)

11570 FURTHER TOPICS IN THE DESIGN OF ANGULAR DISTRIBUTION EXPERIMENTS. J. H. Williamson (Cambridge Univ., Eng.). Nucl. Instr. Methods, 32: 235-8 (Feb. 1965).

Linear programing is used to extract the most precise statistically independent coefficients from given data. An optimal design for a multidetector experiment is given and the practical implications considered. A small bias in the analysis of angular distribution experiments is corrected. (auth)

11571 DETERMINATION OF ALPHA-BETA RATIO FOR LIQUID HELIUM. T. G. Miller (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instr. Methods, 32: 239-41(Feb. 1965).

The α/β ratio for liquid helium was measured by observing the scintillation of the liquid helium directly with a

photomultiplier tube. The α particles are provided by an ^{241}Am alpha source and the β particles are produced by Compton scattering of ^{60}Co gamma rays. The α/β ratio was found to be 0.182. (auth)

11572 A DIGITAL GAIN STABILIZER FOR A MULTIPARAMETER PULSE-HEIGHT-RECORDING SYSTEM. M. Nakamura and R. L. La Pierre (Univ. of California, Berkeley). Nucl. Instr. Methods, 32: 277-88(Feb. 1965). (UCRL-11494)

A digital gain stabilizer is developed for use with a multiparameter pulse-height-recording system. Corrections are made for gain drifts of any origin in the spectrometer system. Stability of peak channel numbers to 0.1% or better is obtained over extended periods of time without significant loss in resolution. A method for stabilizing on a peak at any location in the spectrum is described. This method requires only four decimal switches as compared to the many switches normally used. Three decimal switches select the channel location of the stabilizing peak and another switch selects the number of channels adjacent to the peak to be included for stabilization. Gain corrections are introduced into the system by means of a variable-gain amplifier. This provides an inexpensive method for controlling the gain without requiring any alterations to the existing equipment. (auth)

11573 AN ELECTRICALLY CONTROLLED VARIABLE-GAIN PULSE AMPLIFIER USING DIFFERENT CONTROLLED ELEMENTS. H. Arque Almaraz (Univ. of California, Berkeley). Nucl. Instr. Methods, 32: 283-6 (Feb. 1965). (UCRL-11481)

The problem of automatically controlling the gain of a pulse amplifier with an electric signal is discussed. A simple electrically controlled variable-gain pulse amplifier is described. Different types of variable-resistance control elements are considered: GE344 and Pinlite 15-15 lamp bulbs and field-effect transistors (FET's). An important use of a variable-gain pulse amplifier is in gain-stabilized systems in nuclear instrumentation. An electrically controlled variable-gain amplifier that permits up to ±1 v input pulses with gain-change capabilities of ±21% was constructed. It is a simple, low-cost compact unit that can be introduced into existing stabilizer systems without changing its components. Incremental linearities of 0.08% or better can be expected. Gain modulations up to 100 kc were accomplished with FET's. Very good results are obtained with lamp bulbs when lower speeds can be tolerated, as is the case for a great many present-day experiments. (auth)

11574 A 0.2 PER CENT ACCURATE ALPHA-PARTICLE COUNTER WITH PLASTIC DETECTORS. A. Spernol and O. Lerch (Euratom, Geel, Belg.). Nucl. Instr. Methods, 32: 293-9(Feb. 1965). (In German)

A low-geometry alpha-counter with thin plastic detectors is described. The results of investigations on the possible systematic error effects of this instrument are discussed, and it is shown that accuracies of less than 0.2% can be reached without difficulties. (auth)

11575 DEAD TIME LOSSES FOR DIFFERENTIAL COUNTERS. T. Friese (Hahn-Meitner-Institut fur Kernforschung, Berlin). Nucl. Instr. Methods, 32: 317-20(Feb. 1965). (In German)

The deadtime losses for four input circuits of differential counters were calculated. The relative deadtime loss of the differential counting rate is nearly twice the relative deadtime loss of the input counting rates, if the differential rate is small compared with the input rates. (auth)

11576 A FAST WIDE RANGE SINGLE CHANNEL PULSE HEIGHT ANALYZER. H. Brafman (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Instr. Methods, 32: 321-4(Feb. 1965).

A fast wide range single channel pulse height analyzer is described. The circuit has a double pulse resolution of 40 ns and its dynamic range is 0.1–10 v. The circuit includes a pair of tunnel diodes as current discriminators. The conventional univibrators were replaced by a single timing circuit which linearly varies the bias of both an output and a reset tunnel diode trigger. The upper channel, when activated, prevents the generation of an output pulse by changing the differential bias of the two triggers. The introduction of a threshold trigger in the timing circuit prevents the generation of multiple output pulses in response to a wide input. An output is generated only in response to the leading edge of an input pulse. (auth)

11577 AN INTERNAL CONVERSION COEFFICIENT SPECTROMETER UTILIZING SEMI-CONDUCTOR DETECTORS. H. T. Easterday, A. J. Haverfield, and J. M. Hollander (Univ. of California, Berkeley). Nucl. Instr. Methods, 32: 333-8(Feb. 1965). (UCRL-11524)

A description is given of a device that was designed for the measurement of internal conversion coefficients by simultaneous observation of electron and gamma spectra with lithium-drifted silicon and germanium detectors, respectively. Calibration of the device was made by use of several well-known internal conversion coefficients (^{203}Hg, ^{198}Au, ^{137}Cs, ^{207}Bi, and ^{109}Cd sources). Dependence of the efficiency of the germanium detector for full-energy absorption of gamma rays was determined. Application of the method to the determination of conversion coefficients of the 191-kev transition from ^{197}Pt decay and of the 346-kev transition from ^{197m}Pt decay is described. The following results are obtained: ^{197}Pt: 191-kev transition, ϵ_K = 0.69 ± 0.07, K/L = 5.2 ± 0.6, and ^{197m}Pt: 346-kev transition, ϵ_K = 3.9 ± 0.4, K/L = 1.8 ± 0.2. (auth)

11578 THE EFFECT OF GEOMETRY AND FILLING ON THE CHARACTERISTICS OF BROMINE QUENCHED GEIGER-MÜLLER COUNTERS. K. Schwerd (VEB Vakutronik WIB, Dresden). Nucl. Instr. Methods, 32: 347-51 (Feb. 1965). (In German)

The starting potential, plateau-characteristics, and deadtime of bromine-quenched Geiger-Müller counters were studied as a function of the anode diameter and neon-bromine mixture. A remarkable improvement of the plateau-characteristic was found with increased anode diameter and increased pressure of bromine. Large admixtures of argon to the neon-bromine filling of the counter caused a rise of the starting potential and a deterioration of the plateau-characteristic. The dead-time is found to vary only slightly with the counter voltage for thick anodes and low pressures. (auth)

11579 ON A NEW FAST CHARGE-SENSITIVE PREAMPLIFIER. A. Alberigi Quaranta, M. Martini, G. Ottaviani, and G. Zanarini (Universita, Bologna). Nucl. Instr. Methods, 32: 352(Feb. 1965).

A prototype charge-sensitive preamplifier that works satisfactorily for pulse repetition rates up to 5 Mc is described. The conversion gain is 75 mv/Mev, and the noise is 35 kev (fwhm) at 1 pF detector capacitance. (C.E.S.)

11580 A CRYOSTAT FOR GERMANIUM DETECTORS. J. Lippert (Atomenergikommissionen, Riso, Denmark). Nucl. Instr. Methods, 32: 360(Feb. 1965).

A cryostat was developed for cooling germanium solid state detectors to liquid nitrogen temperature. When in use the cryostat is placed on top of a standard 5-liter Dewar bottle with liquid nitrogen and maintains the liquid nitrogen temperature for 50 to 60 hours. (C.E.S.)

11581 SEMICONDUCTOR DETECTORS FOR NUCLEAR MEDICINE AND BIOLOGY. Stephen S. Friedland, Henry S. Katzenstein, and Michael R. Zatzick (Solid State Radiations Inc., Los Angeles). Nucleonics, 23: No. 2, 56-61(Feb. 1965).

Applications of semiconductor detectors in nuclear biomedicine for detecting radioisotopes in vivo and in uptake studies are discussed. Resolution, noise, dynamic range, and sensitivity are discussed for phosphorus-diffused-junction detectors, surface-barrier detectors, and lithium-drifted detectors. Uses for radioactive assay, in vivo tracer detection, brain probes, gastrointestinal probes, alpha probes, circulation probes, and dosimetry are described. (M.C.G.)

11582 CALCULATING GAMMA EFFICIENCIES IN SCINTILLATION DETECTORS. Bernard J. Snyder and

Geza L. Gyorey (Univ. of Michigan, Ann Arbor). Nucleonics, 23: No. 2, 80: 92-4; 86(Feb. 1965).

A computer program was prepared to find efficiencies of different kinds of scintillation crystals for gamma detection. It can be used for any cylindrical crystal and for any monoenergetic gamma of known energy. The program, called the BURP-1 code, calculates the fraction of monoenergetic gamma rays with energies between 0.01 and 30 Mev, which interact with the radiation detector. A detailed description of the mathematical expressions derived is presented. Results were calculated for two commonly used NaI(Tl) scintillation crystals. (M.C.G.)

11583 HODOSCOPE AND TELESCOPE CONSTRUCTED OF NEON TUBES. B. Bonczak, R. Firkowski, E. Jatczak, and A. Zawadzki (Lodz Univ., Poland). Nukleonika, 9: 417-20(1964). (In Russian)

Glass tubes 1.4 cm in diameter are filled with neon gas at a pressure of 63 cm Hg. The impulse from a coincidence scheme is transmitted to a generator which lights up the tubes through which the ionizing particle passed, and shows the path of the particle through the tubes. A telescopic array is used to determine the axial direction of the shower. The counting efficiency depends only slightly on the applied voltage to the neon tube. An impulse length of 2 to 3×10^{-6} seconds is optimal. The counting efficiency decreases with increasing delay time between passage of the ionizing particle and application of high voltage to the neon tube. The advantages of neon tubes over Geiger-Muller counters are that the position of the ionizing particles can be determined more accurately because of the small size of the neon tube detector, and simpler electronic circuitry can be employed. (TTT)

11584 ABSOLUTE MEASUREMENT OF DISINTEGRATION RATE OF RADIOISOTOPE SOURCES BY X-GAMMA RAY COINCIDENCE COUNTING METHOD. Tamaki Watanabe and Norio Takeuchi (Japan Atomic Energy Research Inst., Tokyo). Oyo Butsuri, 33: 322-7(May 1964). (In Japanese)

The absolute disintegration rate of sources of radioisotopes that decay by electron capture was determined by the x-gamma coincidence counting method. The counting system consists of an x-ray and a gamma detector, two single-channel pulse height analyzers, a fast-slow coincidence circuit, and three scalers. The detectors are of scintillation type with a NaI crystal. An A-1 type low-noise preamplifier with a gain of 25 is used to amplify output signals from the x-ray detector. The x and the gamma rays to be coincided are selected by the respective pulse height analyzers. The resolving times of the fast and slow coincidence circuits are 2 and 6 μsec, respectively. The normality of operation of the system is examined by the absolute measurement of the disintegration rate of a ^{88}Y source. The characteristic x rays and 1.83-Mev gamma rays emitted from ^{88}Y are coincided. The absolute disintegration rate of this source is also measured by the gamma-ray scintillation spectrometrical method with a 3″ϕ × 3″ NaI crystal scintillation detector and a TMC 256 channel pulse height analyzer. The photopeak efficiency of this spectrometer is determined by the use of ^{137}Cs, ^{60}Co, and ^{24}Na sources, the absolute disintegration rates of which are determined in advance by the $4\pi\beta$ counting or $4\pi\beta-\gamma$ coincidence method. The disintegration rate of ^{88}Y sources obtained by the x-gamma coincidence method is in good agreement with that obtained by the scintillation spectrometrical method. (auth)

11585 SUPER RESOLUTION OF RADIATION SPECTRUM. Tamon Inouye (Tokyo Shibaura Electric Co., Ltd.). Oyo Butsuri, 33: 328-33(May 1964). (In Japanese)

A new analyzing method for radiation spectra was developed by use of the technique of the information theory whereby the resolving power is effectively increased about ten times. The reliability of this method was proved by numerical simulation and the increase of the resolving power was confirmed. This method was applied to gamma spectrometry and a small energy difference between two gamma rays from ^{95}Zr was exactly determined. It was also successfully applied to the identification of ^{141m}Nd and ^{139m}Ce in mixture, this identification being otherwise impossible on account of a small energy difference, short life times, and similarity of chemical properties. (auth)

11586 ACTIVITY MEASUREMENT OF TRITIUM WITH MICROCALORIMETER. Osamu Yura and Miwako Kimura (Electrotechnical Lab., Tokyo). Oyo Butsuri, 33: 342-7(May 1964). (In Japanese)

Heat of about 100 μw released from 3C tritiated water is measured with a twin differential type microcalorimeter within an error of 1%. The calorimeter consists of two identical copper cylinders as heat absorber, one holding the sample, the other a measuring coil, both suspended in a vacuum jacket kept immersed in an oil bath. The temperature of the oil bath is controlled to $^1/_{1000}$°C by a thermostat. The measuring coil is heated by a d-c current, whereby the input to the coil to raise the cylinder temperature to the temperature of the sample cylinder determines the heat given off by the sample. The balancing of the two cylinder temperatures is checked with 25 pairs of thermojunctions bridging the cylinders. To avoid the error that arises from thermal inequality between the two cylinders, another heating coil is placed in the sample cylinder, by which means the sought-for heat quantity is determined by a devised method. The disintegration of tritium in the sample is calculated by assuming the mean β energy of this nuclide. To check the correctness of the result, the sample is diluted to the concentration of an NBS standard sample and, by the use of a liquid scintillation counter and on the assumption of the same mean β energy, a comparison is made with an NBS sample. The two are in good agreement with a difference of less than 0.1%. (auth)

11587 MULTI-ANODE 2π GAS FLOW COUNTER FOR LARGE AREA SOURCES. Akira Sekiguchi (Tokyo Univ.) and Kikuzo Sakagami. Oyo Butsuri, 33: 348-54(May 1964). (In Japanese)

A multi-anode 2π gas flow counter for the absolute determination of the radioactivity of large-area sources 14 cm × 18 cm for one, is described. The cathode comprises two parallel brass plates, which are parts of the counter casing. Five 30 mm-spaced anode wires of stainless steel and 0.05 mmϕ are stretched in a plane parallel to and at 15.5 mm from the cathode plates. A large area source of up to several mm thickness is put on the lower cathode plate. Usually, methane gas is used as the proportional region counting gas. In the proportional region, the parallel plate type cathode has advantages over other types. Narrowing of the anode wire spacing does not improve the counter characteristics much. Even in the G-M region, the mutual interference of anode wires has no significant effect on the measurement. (auth)

11588 SINGLE-CHANNEL PULSE-HEIGHT ANALYZER OF HIGH STABILITY. Hajime Iizuka and Ken-ichi Hasegawa (Tokyo Univ.). Oyo Butsuri, 33: 355-61(May 1964). (In Japanese)

A new solid-state single-channel pulse-height analyzer of high stability over a wide temperature range is described. A stable bipolar standard pulse of equal positive and negative areas is generated for every input pulse. The pulse is attenuated according to the channel width, and is added to the input pulse, which is also shaped to a bipolar pulse by a double decay line clipping circuit. Since these pulses have zero d-c level, an adder consisting of a stable feedback a-c amplifier can be employed. The pulse delivered from the adder is applied to a pulse-height discriminator, in which circuit Esaki diodes are used. The system employs only one discriminator. In the temperature range from 0 to 40°C, the threshold level of the discriminator drifts 2 percent of the maximum pulse-height accepted by the discriminator, while the stability of the channel width is better than 1 percent and does not depend on the values of the channel width. Hence, by use of the system with a very narrow channel width, energy measurements of nuclear radiations are achieved with high accuracy. The time resolution of the PHA is about 2 μsec, for the system was designed for NaI (Tl) scintillators. For fast scintillators, it is possible to design the system to obtain

a good performance for input pulse rates of higher than 2 Mc. (auth)

11589 TRACK DETECTORS—A NEW METHOD OF VISUALIZING NUCLEAR PARTICLES. L. Kowalski (Warsaw Univ.). Postepy Fiz., 15: 437-48(1964). (In Polish)

A detector is described for highly ionizing nuclear particles, which leave tracks in a transparent material. The sensitive volume consists of a material such as mica in which the particle leaves localized fissures or defects, which become visible under microscopic examination if the material is properly pre-treated and subsequently pickled in hydrofluoric acid. The mechanism of track formation is discussed, along with methods for optimization. Applications are discussed for such areas as nuclear reactions involving heavy ions, research on nuclear fission, geological applications, possiblities of producing microporous materials, neutron detection, and rapid examination of nuclear emulsions. The possibility of extending track detectors to lower thresholds of specific ionization is also discussed. (TTT)

11590 NEUTRON FLUX AND ENERGY MEASUREMENTS. L. G. Penhale and D. E. Vaughan. p.251-9 of "Radiation Sources." New York, The Macmillan Company, 1964.

The interactions of neutrons with nuclei are discussed. The main types of neutron detectors are described. Neutron detection and energy measurement by induced activity are considered for thermal, epithermal, and fast neutrons. (M.C.G.)

11591 SPARK CHAMBERS. M. I. Daion. p.529-52 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Spark chambers are more easily controlled than bubble chambers and have short memory and dead time. The various forms of discharge across the walls of the chamber are reviewed. Discharge chambers, in which a layer of dielectric on the wall surface limits the spark breakdown current, differ markedly from spark chambers. Large interelectrode distances or small additions of halogen gas to the chamber help limit the discharge current. Discharge chambers may divide into field discharge, trajectory discharge, and track projection discharge types. Spark chambers in magnetic fields are used to measure particle momentum and charge. The greater memory of air mixture chambers as compared to helium-filled ones favors the retention of the true path. Piezodetectors for acoustical detection are employed in addition to photographic methods. Non-light-sensitive methods are especially useful for transmission to data processing machines. Spark chambers are especially useful for detecting neutral particles and particle interactions and measuring the momentum of certain particles. The light weight of the chambers renders them adaptable to many specialized applications. (TTT)

11592 TWO-ELECTRODE SPARK CHAMBER IN MAGNETIC FIELD. A. I. Alikhanyan. p.553-72 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Discharge chambers in magnetic fields that make possible precise determination of particle momentum are surveyed. The limits of applicability may lie as high as hundreds of Bev/c. Development of spark chambers is outlined The rise time of the high voltage pulse in relation to the capacitance of the chamber is a determining factor in obtaining undistorted tracks. Conditions that produce distortions are discussed. Best results were obtained with neon filled chambers at 1.5 atm. The distance between electrodes was increased while track fidelity was maintained. The Arkadiev-Marx generator used at Nor-Amberd is described. A discussion of the mechanism of formation of an inclined track is given together with a consideration of the fidelity of the track to the particle's path. Detection efficiency for individual particles in these chambers is very high, approaching 100% when high voltage pulse delay does not exceed 2μsec. Most of the experiments discussed involved delay times of ½μsec. Detection efficiency for simultaneous particles or for particle showers not known. The curving of tracks when a chamber is placed in a magnetic field and the precise determination of momentum are examined. Illustrations of various tracks are shown. A chamber built by Asatiani and colleagues and made entirely of glass is described; an advantage of such a chamber is reduced off-gassing of the walls. Another chamber with an electrode gap of 40 cm was built to determine radius of curvature of the track more accurately. A chamber built by Asatiani and coworkers has a 50 cm gap and an aluminum foil barrier 40 microns thick; the distortion of tracks in passing through the foil was found to be negligible. A discussion of chambers that detect tracks parallel to the electrodes is given. (TTT)

11593 SCANNING OF BUBBLE CHAMBER PHOTOGRAPHS BY MEANS OF ELECTRONIC COMPUTERS. E. M. Landis. p.578-85 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The form of the input data is discussed. The three parts of the computer program—preliminary scanning, reestablishment of the spatial map, and selection of the hypothesis for the particle-interaction process and estimation of accuracy—are described. A brief review of experimental use of the program and variations introduced is given. (M.J.T.)

11594 (REPORT) SCANNING OF 17 l. BUBBLE CHAMBER PHOTOGRAPHS. Yu. S. Krestnikov. p.586-94 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The measurement process of photographs obtained in a 17-l bubble chamber is described. Scanning of the photographs includes measuring angles and track lengths and estimating ionization and multiple scattering and is performed by the method of reprojection with reestablishment of the working volume of the chamber on a 1-to-1 scale for all three coordinates. Geometrical considerations of the reprojection method are discussed. The reprojection apparatus ITEF is described, including the means for object reprojection, construction peculiarities, and the measurement table. The accuracy of measurements carried out with the apparatus is considered. (M.J.T.)

11595 ABSOLUTE DISINTEGRATION RATE MEASUREMENT OF BETA-EMITTERS BY APPLICATION OF EFFICIENCY TRACING TO 4π-LIQUID SCINTILLATION COUNTING. J. Steyn and F. J. W. Hahne (Council for Scientific and Industrial Research, Pretoria). p.30-42 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

A method is described in which the applicability of the well-known coincidence method of absolute radioactivity determinations is extended to the measurement of those nuclides decaying by beta-emission only. Suitable β-γ-nuclides are added, as efficiency tracers, to the β-emitter dissolved in a liquid scintillator forming the β-detector in a 4π-β-γ-coincidence counting arrangement. Results of applying the method to the standardization of ^{35}S solutions are given. (auth)

11596 AN ENERGY-INDEPENDENT CADMIUM SULPHIDE DETECTOR. G. C. Snyman (Atomic Energy Board, Pretoria). p.68-71 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963. (In Dutch)

The response to x and γ radiation for the energy range 25 kev to 1.25 Mev was determined for a CdS detector. The response of various CdS detectors to a dose rate of 2000 r/h with 12v applied to the CdS crystal is given. The approximate thickness of lead absorber to make the sensitivity of the detector independent of quantum energy, was graphically determined from the measured sensitivity. (P.C.H.)

11597 THIMBLE-TYPE ION CHAMBER /Q-747/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-919)

The ionization chamber is used to read high level intensity γ radiation for remote operation. The thimble is ⅝ in. OD, ½ in. ID, and is constructed of thick polystyrene. The

cylinder is 1/8 in. long with a 5/16 in. hemispherical bottom. The hemispherically shaped electrode is constructed of polystyrene 1/8 in. OD, 5/8 in. long with a 1/16 in. radius. The instrument is 30 in. long. (J.R.D.)

11598 PROGRAMMED CRYSTAL ORIENTER /Q-2103/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1158)

An automatic control system used to scan reactor fuel plates is described. A collimated x-ray beam scans the High Flux Isotope Reactor (HFIR) fuel plate, and a scintillation counter detects variations of transmitted x-ray intensity to indicate the fuel distribution and total fuel within a plate. The readout is a printed paper tape and a strip-chart record. The system will perform with an accuracy of ~1%. (J.R.D.)

11599 DECADE SCALER, 10 MC (Engineering Materials). (California. Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1162)

A modular design scaler that uses solid state circuitry and printed boards is described. One 10 Mc decimal counting unit and six 1 Mc decimal counting unit modules give a count capacity of 10^7. The scaler also contains a Gate and Scaler Control and a 10-Mc pulse height discriminator. Two complete scalers (18 modules) plug into a standard rack mounting frame of 3½ in. front panel height. The rear panel mounts the power supply module and signal input connectors. The front panel is made up entirely of adjacent plastic sections attached to each printed circuit board. The module contains a signal gate for gating the scaler and circuitry for generating the scaler reset pulse. The 10-Mc pulse height discriminator generates a fast output pulse to trigger the scaler and discriminates against low amplitude pulses by generating an output pulse only when the input pulse exceeds a predetermined level. (J.R.D.)

11600 PCP II MULTISECTION ION CHAMBER /Q-2618-107/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1169)

A neutron detector designed primarily for the control and safety of the ORNL Fast Burst Reactor is described. The detector has two electrically independent, B-coated, uncompensated chambers which share the same gas. These chambers are N_2-filled at 1000 ± 20 mm Hg. The electrodes are closely spaced parallel plates. The instrument is 35 in. long with a 2.5-in. maximum OD. It has a Ni casing and a 5/16-in.-thick lead shield. The chamber and cabling are designed for a maximum voltage between electrodes of 600 v and a maximum temperature of 125°C. The chamber and cabling are moisture proof and the cable will withstand an accumulated radiation of 5×10^8 rads. (J.R.D.)

11601 RADIATION MONITOR FOR THE INVESTIGATION OF CHEMICAL KILNS. J. J. Keller and Liem Tjong Sien. Acta IMEKO (Intern. Mess-tech. Konf.), 1964, 465-74. (CONF-640902-6)

A transistorized scintillation monitor is described, which may replace other expensive standard monitors used in investigations of chemical plants. In radiation measurements there is frequently a long distance between the measuring probe and the registering part of the monitor. The applied electronic schemes make it possible to connect the probe to the recorder with a single lead coaxial cable over 300 ft long. This is especially convenient in cases when a flexible array of many monitors is needed. (auth)

11602 INTERNAL Sr^{90} BETA RAY DOSIMETRY WITH FLUORODS. 12p. (CONF-556-6)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Dosimetric problems associated with fluorods are discussed. A reproducible technique for calibration of fluorods employing gelatin phantoms is described. Advantages of the fluorods include linear response to dose over a large range and also dose-rate independence. If low-Z fluorods are used the fluorescence remains constant over many months and thus the dosage can be re-read at any time. The performance of available fluorods is discussed. (P.C.H.)

11603 NEUTRON SPECTROMETERS AT THE SWEDISH REACTORS. U. Dahlborg, K. E. Larsson, and K. Skoeld (Royal Inst. of Tech., Stockholm and Aktiebolaget Atomenergi, Stockholm). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/36, 21p. (CONF-804-9)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The time-of-flight spectrometers at the 600 kw, heavy-water-moderated reactor R1 and the 30 Mw, light-water-moderated reactor R2 are described, together with the triple-axis crystal spectrometer at the R2 reactor. Be filters, crystals, and choppers provide monochromation in the time-of-flight spectrometers. The performance of the instruments is discussed, as well as their suitability for certain measurements. (D.C.W.)

11604 COUNTER TUBE. Adolf-Werner Elbel and Gert Podzuweit (to Landis & Gyr AG). German Patent 1,180,071. Oct. 22, 1964. Priority date Mar. 17, 1961, Switzerland.

A counter tube is described which has no metallized surfaces exposed to the discharge volume and which endures rapid changes in temperature. The counter tube is composed of a plurality of glass members sealed together. They are coated with layers of electrically semiconducting substances. The semiconducting electrodes extend from the surfaces confronting the discharge volume via the vacuum seals to the outside of the glass members. (Gmelin Inst.)

11605 MECHANICAL SIMULATOR FOR THE SIMULATION OF RADIATION-MONITORING INSTRUMENTS. Kurt Friedrich, Wilhelm Muscheid, Klaus Oberreich, and Gerhard Koch (to Total Kommanditgesellschaft Foerstner & Co.). German Patent 1,180,072. Oct. 22, 1964. Filed Oct. 26, 1962.

The mechanical simulator described, which is for the reproduction of a predetermined time-dependent radiation intensity, consists of a pointer lever and a set of different disks. Each disk corresponds to a different time function. The pointer level is actuated by one of the disks. This pointer moves in front of a scale and for the simulation of different time functions it is switched over from one disk to another. (Gmelin Inst.)

11606 METHOD OF FABRICATING SURFACE BARRIER. R. J. Fox (to U. S. Atomic Energy Commission). U. S. Patent 3,163,915. Jan. 5, 1965.

An invention relating to the fabrication of surface barrier detectors is described which will produce uniform units having improved geometry on a routine basis, by using a diglycidal ether of bisphenol A with ethylene diamine as a curing catalyst and an amine type hardener. (AEC)

Radiation Effects

11607 SPACE RADIATION AFFECTS MOS FET'S. Harold L. Hughes and Ronald R. Giroux (Naval Research Lab., Washington, D. C.). Electronics, 37: No. 32, 58-60 (Dec. 28, 1964).

Radiation effects studies were conducted on commercially available metal-oxide semiconductor (MOS) field-effect transistors (FET) earmarked for satellite use. Six p-channel and five n-channel MOS transistors were exposed to 10^6 rads of ^{60}Co gamma radiation. Both types of transistor were found to be very susceptible to space-type radiation. Radiation effects on the MOS transistor electrical characteristics are tabulated. (H.D.R.)

11608 DESIGNING AGAINST SPACE RADIATION. PART I. Henning H. Lind Olesen (General Electric Co., Philadelphia). Electronics, 37: No. 32, 61-71(Dec. 28, 1964).

Nuclear radiation environments that must be accounted for in the design of electronic systems for use in space are examined. The types and levels of radiation that may be encountered in the Van Allen belts or that is produced by solar flares, nuclear reactors, and nuclear explosions are discussed. The various interaction methods of radiation with material atomic structure are examined to indicate how radiation affects electronic circuit materials and elements. (H.D.R.)

11609 EFFECT OF GAMMA IRRADIATION ON THE ENERGY OUTPUT OF RUBY LASER CRYSTALS. W. R. Davis, A. C. Menius, Jr., M. K. Moss, and C. R. Philbrick (Univ. of North Carolina, Raleigh). J. Appl. Phys., 36: 670-2(Feb. 1965).

A ruby laser crystal was irradiated with ^{60}Co gamma rays to a total dosage of ~800 R. Comparison of a pre- and post-irradiation firing of the laser crystal with the same input energy indicated a definite increase in output energy. The laser energy output measured by a calorimeter indicated an increase of approximately 70% over the pre-irradiation output. The increased output energy of the ruby laser after gamma irradiation persisted for a number of pulsed firings at the same input energy. Further experiments showed that for small total dosages (of the order of 500–1000 R) the laser output energy approached its pre-irradiation value after prolonged firing. (C.E.S.)

11610 BEHAVIOR OF SOLID DETECTORS IN A FLUX OF RADIATION. R. Schuttler, B. Girault, J. Lebailly, J. P. Noel, and S. Passe (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 127-53(1964). (In French)

The manner in which radiations perturb the functioning of a solid detector is studied. It is shown that, independently of the destructive effects, transitory perturbations, at least as interference, can distort the measurements. The action of the radiation was shown in two fashions: the first classical by the variation of the collection yield (connected to the recombination velocity and the mobility) and the other corresponding to the transitory variation of the internal geometry of the detector. (J.S.R.)

11611 LOW-RATE PROTON BOMBARDMENT OF DIFFUSED SILICON COUNTERS. R. E. Scott (TRW Space Technology Labs., Redondo Beach, Calif.). Nucl. Instr. Methods, 32: 171-2(Jan. 1965).

Diffused Si detectors were irradiated with protons of approximately 11 Mev for about 1 hr, to integrated fluxes of about 10^{10} and 2×10^{11} protons/cm^2. A decrease in capacitance was observed; after a 10-day recovery period, capacitance was very nearly at pre-irradiation values. It is concluded, from this and previous experiments, that the enhanced formation of divacancies in proton irradiations is due to the nature of the track of the typical recoil atom, and not to an irradiation-rate-dependent interaction. (M.J.T.)

ISOTOPE TECHNOLOGY

General

11612 THE USE OF γ-RADIATING ISOTOPES FOR DETERMINING THE MOISTURE CONTENT OF BUILDING MATERIALS. J. Gémesi and D. Voedroes. Epitoanyag, 15: 275-9(July 1963). (In Hungarian)

The suitability of various radioisotopes for determining the moisture content of building materials was investigated. The radiation source was enclosed in a Pb cube (a = 10 cm). The radiation was emitted through a d = 10 mm channel, then collimated through a second Pb cube with a 10-mm channel, passed through the sample, collimated again through a channel in a Pb cube and passed through one more Pb cube with a channel which served as a shield in front of the detector. A scintillation detector and an "Orion" EMG 1872 counter were used to measure the γ-radiation. ^{60}Co, ^{192}Ir, and ^{203}Hg were tested as radiation sources. Measurements with specially designed equipment showed that a change in moisture content corresponding to a 1-mm-thick water layer can be measured adequately with ^{203}Hg. One of the advantages of the method is that accuracy is not impaired by increasing moisture percentages. Greater accuracy of measurement can be obtained with sample materials of greater density and thickness. (auth)

11613 HALF LIFE OF THORIUM-232. L. J. Le Roux and L. E. Glendenin (Argonne National Lab., Ill.). p.83-94 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

The half life of ^{232}Th was determined with high accuracy by using a liquid scintillation technique to measure the absolute specific alpha activity of purified thorium separated by solvent extraction from other radioactive elements in the ^{232}Th decay chain. The ^{228}Th contribution was calculated from the known time of separation of the thorium from monazite sand, and a small correction was made for the presence of ^{230}Th by alpha pulse-height analysis. The thorium content of each counted sample was determined titrimetrically. The half life was found to be 1.401×10^{10} years with an estimated uncertainty of 0.007×10^{10} years (0.5%). (auth)

11614 INTERNATIONAL DIRECTORY OF ISOTOPES. Third Edition. (International Atomic Energy Agency, Vienna). 1964. 494p. STI/PUB/83. $9.00; S 189,-; £2.14.0; F.Fr.36.-; DM 31,50 (IAEA).

Tables are presented which give the supplier source, activity, and other characteristics of radioisotopes, some stable isotopes, and their compounds. Safe handling of radioactive materials and service irradiations are also discussed. (D.L.C.)

Industrial Applications

11615 (EUR-1909.d) DIE ANWENDUNG GESCHLOSSENER RADIOISOTOPE IN DER INDUSTRIE. (FALLSTUDIEN 1 BIS 4). (The Application of Sealed Radioisotopes in Industry. (Case Studies 1 to 4)). H. Wieczorek and H. Erhardt (Laboratorium Prof. Dr. Berthold, Wildbad im Schwarzwald, Germany). 1964. 37p. Dep.(mn).

In this investigation the following individual cases or groups of cases of isotope application were studied: coal-fired steam-generating power plant, mineral wool manufacture, thermal cracking plant, and mandrel failure prevention in pilger cold-rolling plant. For this purpose, data relating to technology and industrial science must be meticulously collected during operation. In addition, the technical, economic and social demand structure is systematically analyzed with reference to the application of radioactive substances and with a special view to the automation of manufacturing processes. (auth)

11616 (SGAE-BL-9/1964) BIOCHEMISCHE PROBLEME BEI DER PASTEURISIERUNG VON FRUCHTSAFTEN DURCH BESTRAHLUNG. (Bio-chemical Problems in the Pasteurization of Fruit Juice by Irradiation). K. Kaindl, H. Altmann, G. Stehlik, and H. Gaisch (Österreichische Studiengesellschaft für Atomenergie G.m.b.H. Institut für Biologie und Landwirtschaft, Seibersdorf). [1964]. 7p. (CONF-640501-1). Dep.(mn).

From Biophysical and Radiobiological Meeting, Marburg, Ger.

The action of radiation γ on the growth processes of yeast cells was investigated on various yeast strains. The course of the CO_2 production in correlation with the cell increase showed that for several generations the increase of the yeast cells exposed to radiation could not be distinguished from the controls. A stage of inhibition then occurs, followed by another growth stage. Studies were made on the extent of the DNA synthesis with labeled thymidine. There was a reduction in the DNA synthesis in both of the first stages. The RNA synthesis showed great fluctuations. Analysis of the pools of free nucleotides made on irradiated yeast showed a sharp decrease of the ATP concentration. Applications of the findings in the radiation processing of fruit juice are discussed briefly. (J.S.R.)

11617 (TID-21434) TECHNICAL AND ECONOMIC CONSIDERATIONS FOR AN IRRADIATED WOOD-PLASTIC MATERIAL. Final Report. F. D. Iannazzi, P. L. Levins, F. G. Perry, Jr., and R. S. Lindstrom (Little (Arthur D.) Inc., Cambridge, Mass.). Sept. 1, 1964. Contract AT(30-1)-3332. 108p. Dep.; $1.00(OTS).

Results are presented of a study of the commercial utility of irradiated wood-plastic composites, which are made by impregnating wood with a thermoplastic monomer and polymerizing the monomer in situ by irradiation. Such composites are characterized in the study. All the possible applications of composites are enumerated, and the more promising ones are selected on the basis of estimated cost and performance. Some judgements are made of these applications. Recommendations are given for a future applied research and commercial development program. (D.L.C.)

11618 THEORETICAL AND TECHNOLOGICAL CONSIDERATIONS CONCERNING LARGE IRRADIATORS FOR THE TREATMENT OF AGRICULTURAL AND FOOD PRODUCTS. L. Brunelet. Ann. Nutr. Aliment., 17: B325-64 (June 1963). (In French)

An outline is given of the physical and the technological basis of food irradiation. After a short historical introduction, irradiation sources and the geometry of irradiation are discussed. To illustrate the theoretical considerations with an example, the food irradiation plant of the Centre Lyonnaise des Applications Atomique in Dagneux near Lyon is described. Diagrams and photos are shown of the operation of the irradiation plant, which has a capacity of 1 million curies of ^{60}Co. Safety measures and the removal of heat and ozone from the irradiation chamber are discussed. (OID)

11619 A STUDY OF THE RADIATION RESISTANCE OF CERTAIN MICROORGANISMS INJECTED INTO BOILED MINCED HAM IN METAL CONTAINERS. G. de Saint-Aubert. Ann. Nutr. Aliment., 17: B405-25(June 1963). (In French)

This investigation was conducted under conditions as similar as possible to those conditions in which contamination actually occurs. Precooked minced ham was inoculated with the bacteria, which are found in improperly preserved meat products. The inoculated product was put into ordinary metal storage boxes and sealed. The sealed boxes were exposed to a γ flux of 500,000 rad/hr from a 3000-C ^{60}Co source, at 10°C for 48 hr. For each type of bacterium, 3 tests were made: RO for inoculated and unirradiated; RX for inoculated and irradiated; T for uninoculated. After irradiation, samples were drawn from each of the boxes and subjected to the customary bacteriological investigations. Tabular results showed that inactivation requires the following doses: Clostridium bifermentans, 2,000 krad;

Bacillus cereus (spore-forming form), 2,000 krad; Streptococcus faecium, 1,500 krad; Streptococcus faecalis, 300 krad; Salmonella typhi murium, 300 krad; Escherichia coli, 200 krad; Staphylococcus aureus, 150 krad; and Bacillus cereus (vegetative form), 150 krad. (OID)

11620 FACTORS PRODUCING ORGANOLEPTIC CHANGES IN IRRADIATED FOODSTUFFS. P.-L. Sarrazin and P. Vidal. Ann. Nutr. Aliment., 17: B463-74 (June 1963). (In French)

Changes produced by radiation using 625-C (100 krad/hr) and 3000-C (400 krad/hr) ^{60}Co γ sources were studied. Considering one specific source, organoleptic changes depended on the type of product, its state of maturity, the total dose applied, the environment, and the packaging in which the product was exposed to irradiation. For fresh fruits and green vegetables, doses under 300 krad produced no changes, doses between 300 and 400 krad caused changes in texture, and doses above 400 krad caused deterioration in flavor and odor. With marine products, sterilization doses produced unpleasant odors and flavors, but pasteurization doses were applied without side effects. The irradiation of raw beef, pork, lamb, and poultry with sterilization doses produced slight changes which were similar to changes caused by cooking. The environment was considered because O in the air might produce radiooxidation and radiolysis of proteins. The packaging material might also contribute to changes on irradiation, but good results were obtained with plastic covers. It was concluded that radiopasteurization is preferable to radiosterilization. To date the best results were obtained with a combination of the former with either heat or cold treatment depending on the nature of the product. (OID)

11621 COMPARATIVE STUDY BY INFRARED SPECTROPHOTOMETRY OF SEVERAL ALKALOIDS PREVIOUSLY STERILIZED IN AQUEOUS SOLUTION BY GAMMA RADIATION. P. Bonet-Maury, Ch. Lormand, and J. Guy. Ann. Pharm. Franc., 22: 405-10(1964). (In French)

The techniques of radiosterilization by γ rays or accelerated electrons, already studied on a laboratory scale for dressings, catguts, vaccines, injectable solutions, are now being used industrially. However, in spite of their bactericidal powers, these radiations have a radiochemical activity and it is important to detect alteration of the products submitted to these sterilization methods. The infrared absorption spectra of various alkaloids or alkaloid salts exposed in aqueous solution to radiosterilization by ^{60}Co γ radiation were determined and the results were compared with the spectra of control samples. No spectral modification was detected for caffeine, emetine chlorohydrate, and morphine chlorohydrate, but sparteine sulfate and strychnine sulfate showed important modifications in the absorption curves. (tr-auth)

11622 RADIATION STERILIZATION OF BACON FOR MILITARY FEEDING. A. Anellis, N. Grecz, D. A. Huber, D. Berkowitz, M. D. Schneider, and M. Simon (Army Natick Labs., Natick, Mass.). Appl. Microbiol., 13: 37-42(Jan. 1965).

Sliced bacon, cured bacon, and bacon packed in cans and seeded with Clostridium botulinum (6×10^5 spores per can of strains 33A or 41B or with 3×10^8 spores per can of strains 36A, 12885A, 9B, or 53B) was irradiated to various dose levels with γ radiation. Evidence provided by swelling, toxicity, and recoverable C. botulinum with 2,200 inoculated, irradiated cans demonstrated that: 4.5 Mrad were more than adequate as a sterilization dose; the experimental minimal sterilizing dose was 2.0 Mrad, and the theoretical 12-log reduction dose was 2.65 or 2.87 Mrad depending on the method of calculation; some spoilage occurred at dose levels below 2.0 Mrad; all visible spoilage of irradiated bacon was due to strains 33A and 12885A only, whose D values were, respectively, 0.141 and 0.177 Mrad based on spoilage data, and 0.221 and 0.188 Mrad, respectively, when based on recovery data; toxic cans did not always result in swelling, nor did swollen cans always produce toxic spoilage; and viable C. botulinum can exist for at least 8 months in storage at 30 C without producing visible or toxic spoilage at doses below 2.0 Mrad. (auth)

11623 SAFETY OF FOOD STERILIZATION BY IONIZING RADIATION. Edward E. Dean and Donald L. Howie (Army Natick Labs., Mass.). Bull. Parenteral Drug Assoc., 18: 12-26(May-June 1964).

An evaluation of the safety of food sterilized by γ rays and electron beams is made. It is concluded from exhaustive wholesomeness studies that there is no evidence that consumption of irradiated foods adversely affects the biologic end points used to test the safety of irradiated foods. There are small, and, as yet unexplained, biochemical changes. However, these changes do not appear to cause a reduction in nutritive value or increase the danger of chronic toxicity. Induced radioactivity was not found in food sterilized by ^{60}Co or electrons less than 11 Mev. Based on the 12D concept, 4.5 Mrad has been established as the sterilization dose, but there is evidence that a lower dose is just as effective in preventing spoilage in some types of food. Also discussed are the types of foods which have been radiosterilized or pasteurized, and the chemical changes induced in the foods, and the effect of radiation on vitamins. (TCO)

11624 PROGRESS OF FOOD IRRADIATION WORK AND PROGRAMMES IN O.E.C.D. MEMBER COUNTRIES. Food Irradiation, 5: No. 1-2, A2-12(July-Dec. 1964).

Research on food irradiation in Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, the United Kingdom, and the United States is summarized. (M.C.G.)

11625 PRESERVATION OF VENEZUELAN VEGETABLES BY IRRADIATION. J. Solanas and A. Darder (Instituto Venezolano de Investigaciones Cientificas, Caracas). Food Irradiation, 5: No. 1-2, A13-21(July-Dec. 1964).

A pilot experiment was carried out to investigate the feasibility of preserving various food products by ionizing radiations. The products selected were potatoes, onions, and strawberries. A 500-C ^{60}Co gamma facility was used for the program and different doses were applied. Potatoes and onions were stored after irradiation at 10 to 22°C and 60 to 95% humidity. As a result, sprouting in the potatoes wa sprevented with a dose of 10,000 rads, and the loss of weight was 7% after 8 months of storage. A dose of 3000 rads prevented sprouting in onions and the loss of weight at the end of 8 months was 15%. It was possible to preserve strawberries in good condition for a period of 25 days after their irradiation at 200,000 rads and storage at 3°C. (auth)

11626 THE HEAT ASPECT OF RADIATION STERILIZATION. L. Roussel (Conservatome, Lyon). Food Irradiation, 5: No. 1-2, A25-6(July-Dec. 1964).

In the radiosterilization of foodstuffs, there are some risks of heating. Heat exchanges may be low because the contents are compact, metal containers may be used and may become heated and the surrounding atmosphere may not be cool enough. Some studies were also carried out at much higher doses than those required for sterilization in order to observe the evolution of certain constituents. In the case of flour or starch given 10 Mrads or more in order to follow the changes occurring in carbohydrates, such a dose may result in a maximum temperature rise of 85°C. In certain cases, therefore, it mgiht be worth while to allow for the temperature factor, which may be lost if the products have had time to cool between irradiation and subsequent handling. (auth)

11627 PRESERVATION OF FRESH UNFROZEN FISHERY PRODUCTS BY LOW-LEVEL RADIATION. I. INTRODUCTION. Richard O. Brooke and Maynard A. Steinberg (Bureau of Commercial Fisheries Technological Lab., Gloucester, Mass.). Food Technol., 18: 112-13 (July 1964).

The effect of low-level γ radiation on the keeping quality and acceptability of haddock (Melanogrammus aeglefinus), cod (Gadus morhua), pollock (Pollachius virens), ocean perch (Sebastes marinus), clams (Mya arenaria), and other fish and shellfish was studied. The application of radiation preservation to fish is reviewed and objectives of this program are described. Low-level radiation plus refrigeratio

has shown promise of extending the shelf life of seafoods without seriously changing normal flavor and odor or nutritional values. Cobalt-60 is the most satisfactory source of γ rays for the preservation of food at the present time. The beneficial effect of low-level irradiation is largely the result of a large reduction in bacterial flora. Organoleptic analyses are used to determine optimum conditions for the radiation preservation of clam meats and haddock fillets, and the effects of this radiation on the amino acid and B-vitamin content, are to be presented. This pasteurizing effect is largely the result of a reduction in the bacterial flora. The predominant bacterial flora of freshly caught fish or of freshly cut fish fillets is the Pseudomonas group, which compose ~60% of the total flora. Achromobacter is usually the second largest group, varying from 14 to 40%. As spoilage proceeds in fish, the Pseudomonas group may increase to 90% of the microbial population, but low-level radiation virtually eliminates the Pseudomonas group. With fishery products subjected to different treatments and exposed to radiation-pasteurization doses of 50,000 to 750,000 rad the resulting extension of refrigerated storage life varies from 7 days to 166 days, depending on the species. Samples irradiated at 450,000 rad or less had the greatest acceptability. Such irradiation nearly tripled the storage life of butterfish and doubled that of cod. (BBB)

11628 FLAVOR STUDIES OF IRRADIATION-STERILIZED CHICKEN. Helen L. Hanson, Marian J. Brushway, and Hans Lineweaver (Dept. of Agriculture, Albany, Calif.). Food Technol., 18: 141-6(Nov. 1964).

Experiments were conducted to investigate the flavor problems of radiation-sterilized chicken, and to seek means of preventing or reducing adverse changes. Enzymes were generally inactivated by heat treatment before storage because preliminary studies confirmed reports that the flavor of samples wherein enzymes remained active deteriorated during storage at elevated temperatures. Vacuum- or nitrogen-packed chicken was irradiated with 4.5 to 4.6 Mrad and stored at 21 to 38°C. Other variables included dose rate, temperature during irradiation, cooking method, and inclusion of charcoal packets in cans. A taste panel readily detected the odor and flavor induced in chicken by 0.1-Mrad irradiation at ambient temperature. Deep-fat frying usually reduced unpleasant odor and flavor more than cooking methods not using fat. Practically no irradiation odor and flavor formed when samples were irradiated at −20°C or lower. Since irradiation odor and flavor decreased during storage at elevated temperature, odor and flavor differences between samples irradiated at subfreezing and those irradiated at ambient temperature were less after storage than they were immediately after irradiation. Activated charcoal packed with the chicken parts reduced adverse odors and flavors. It is concluded that a combination process including enzyme inactivation prior to irradiation, irradiation at subfreezing temperature, packing with charcoal, and deep-fat frying should yield irradiation-sterilized chicken with little adverse flavor. (BBB)

11629 IONIZING RADIATION IN VETERINARY MEDICINE. A. A. Ressang. Hemera Zoa, 68: 13-20(1963).

The use of ionizing radiation for preventing spoilage in meat and milk is considered. Direct hit and indirect effect theories are discussed in relation to bacterial destruction. Radiotoxicity, radiation effects on flavor, and minimum doses required for preservation are reviewed. It is pointed out that a radiation dose sufficient to destroy Clostridium botulinum has yet to be discovered. (H.M.G.)

11630 EFFECTS ON FRESH FRUITS AND VEGETABLES OF PASTEURIZING GAMMA-RADIATION DOSES. T. A. Truelsen (Atomenergikommissionen, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138, 63(1964).

An investigation was carried out on freshly harvested samples of strawberries, raspberries, black currants, sour cherries, plums, apples, tomatoes, cauliflower, and asparagus. Only with strawberries was it possible to obtain any prolongation of the normal cold storage period after exposure to pasteurizing radiation doses. The other products were not suited for radiation treatment, either because it was impossible to obtain any general prolongation of the storage period or because undesirable properties were induced such as changes in taste and texture, discoloration, changes in color development, or increased susceptibility to attacks by microorganisms. (BBB)

11631 THE ROLE OF FREE AND BOUND WATER IN IRRADIATION PRESERVATION: FREE RADICAL DAMAGE AS A FUNCTION OF THE PHYSICAL STATE OF WATER. Gary Wedemeyer and Alexander M. Dollar (Univ. of Washington, Seattle). J. Food Sci., 29: 525-9(Oct. 1964).

The role of bound and free water, as sources of and vehicles for free radicals in the irradiation pasteurization of fisheries products, was investigated in studies of ^{60}Co irradiation of English sole (Parophyrus vetulus) fillets dehydrated to various residual moistures in the range of 2 to 70% by three methods: (1) the wet-freeze drying method at −50°C; (2) the use of commercial freeze-drying equipment; and (3) ethanol-water mixtures in the range of 5 to 70% water. The fillets had been previously equilibrated with aqueous 0.1% cysteine. Model systems using cellulose to replace the fish tissue were also used. The samples were irradiated at 1 Mrad in an air, nitrogen, or oxygen atmosphere. The destruction of −SH groups was measured and related to the amount and physical state of the tissue water. As free water was removed, destruction steadily increased, reaching a maximum at about 20% moisture. Destruction decreased markedly at moisture levels below 10%, and calorimetric measurements confirmed that 10% moisture was about the level of bound water in this species. Thus dehydration favors the reaction of solute molecules with free radicals formed in the free water of muscle cells. At moisture levels greater than about 20%, simple free radical recombination is more likely than reaction with solute molecules, while below 20% moisture the reverse is true. Both energy transfer and bound-water-generated free radicals appear to be of relatively minor importance in fresh tissue. Only the free water of the fish muscle appears to be of major importance as a free radical and peroxide source, although bound water perhaps participates to a limited extent. The model systems supported the data obtained using fish muscle tissue. (BBB)

11632 EFFECT OF IONIZING (GAMMA) RADIATION ON ASCORBIC ACID AND THIAMIN IN FOODSTUFFS. Oldrich Vincent (Purkyne Military Inst. of Medical Research, Hradec Kralove, Czechoslovakia). J. Hyg. Epidemiol. Microbiol. Immunol. (Prague), 5: 248-56(1961).

The effect of ^{60}Co γ irradiation at a dose rate of 25 R/min on the content of vitamins in various foodstuffs was investigated. Preliminary experiments showed that ascorbic acid and thiamine in solutions are destroyed by the action of ^{60}Co radiation. The degree of destruction is directly correlated to the radiation dose and indirectly related to the concentration of the vitamin. Destruction of the vitamins ceases when irradiation is discontinued; persistence of the effect of radiation was not observed. The degree of inactivation of ascorbic acid and thiamine depends on the total radiation dose, not on its intensity. Irradiation of crystalline vitamin preparations with large doses does not reduce their vitamin activity, but alters their color: ascorbic acid turns darker and thiamine turns pink. Irradiation of thiamine solution produces an odor of putrefaction. Irradiation of potatoes with a dose of 67,000 R, carrots with 53,580 R, onions with 65,300 R, and tomato puree with one MR does not destroy their ascorbic acid content. Slight destruction (14.9%) occurs in pasteurized milk fortified with ascorbic acid and irradiated with a dose of 374,000 R. Irradiation with doses of 4.2 and 2.6 MR causes only slight destruction of thiamine in wheat meal (13.3%) and rye bread (22.4%). Marked destruction of thiamine occurs in pork irradiated with a dose of 700,000 R (96.7%), in sweetened condensed milk irradiated with two MR (85.4%), and in pasteurized milk irradiated with 147,000 R (35%). Fortification with ascorbic acid is an effective method of protecting thiamine in milk from the destructive effect of radiation. The degree of destruction of ascorbic acid and thiamine in foodstuffs is determined by the radiation dose and the concentration

of the vitamins. The percentage of destruction is directly related to the water content of the foodstuffs and not to the chemical properties of the vitamins. Irradiation of foodstuffs prolongs the time for which they can be stored and does not increase the loss of vitamins in storage. The only exception were potatoes, in which inactivation took place somewhat more rapidly during storage than in nonirradiated specimens. As in vitamin solutions, the destruction of ascorbic acid in foodstuffs is presumably caused by the indirect action of ionizing radiation via free radicals which are formed during radiolysis of water. This was confirmed by the existence of the dilution effect in irradiation of vitamin solutions, by the greater stability of crystalline preparations, the greater radioresistance of foodstuffs with a low water content, and by the protective effect of ascorbic acid on thiamine. Important changes in the organoleptic properties of irradiated foodstuffs, which might make them unfit for consumption, were not found. (BBB)

11633 TEHNICA NUCLEARA IN SPRIJINUL PRODUCTIEI. UNELE REALIZARI ALE INSTITUTULUI DE FIZICA ATOMICA AL ACADEMIEI R.P.R. (Nuclear Industry in the Support of Production. Some of the Achievements of the Institute of Atomic Physics of the Academy of the Rumanian Popular Republic). Horia Hulubei, Florin Ciorascu, Paul Draghicescu, Licinu-Ioan Ciplea, Tiberiu Braun, and Iulian Leibovici, eds. [Bucharest], Publishing House of the Rumanian Popular Republic, 1963. 252p.

The application of radioactivity to various industrial processes is discussed. This requires complex, coordinated activity, including the fabrication of radioisotopes, the development and the manufacture of the required electronic instrumentation, and the training of personnel in the field of radiometric measurements and in a specific industrial field. Therefore, a reactor was built and new applications developed. The oil industry makes use of radiometric methods, which include well logging, use of isotopes in the extraction processes, and the proper switching of various products flowing through the same pipeline, into the specified tanks. Isotopic labeling techniques are used in metallurgical operations for fabricating high-grade alloys and for determination of wear on furnace linings. Radioactive tracers are also used in hydrological studies, for leak detection in aquaducts, in the study of the dispersion of residual waters in the Black Sea, etc. The various analytical and fabrication methods are reviewed, together with the status of the closely associated fields, such as instrumentation, computer techniques, radiospectrography, etc. The instruments developed are listed. (TTT)

11634 NATIONAL CONFERENCE ON NUCLEAR ENERGY; APPLICATION OF ISOTOPES AND RADIATION. Proceedings held in Pretoria, April 5-8, 1963. Pelindaba, South Africa, Atomic Energy Board, 1963. 650p. (CONF-630403)

Sixty-one articles are included; separate abstracts were prepared for 24. The remaining 37 articles not abstracted in NSA include information on: environmental and background radiation exposure; equipment for measuring radiation exposure; and the use of radioisotopes in geology, medicine, agriculture, biology, and industry. (P.C.H.)

For abstracts of individual papers see: 10779, 10780, 10887, 10888, 10889, 11032, 11033, 11034, 11035, 11036, 11234, 11257, 11458, 11459, 11460, 11461, 11462, 11595, 11596, 11613, 11635, 11636, 11765, and 11813.

11635 THE USE OF GAMMA RAYS IN THE STORAGE OF FRESH FRUIT AND POTATOES. F. N. Matthee and Lerine Potgieter (Fruit and Food Tech. Research Inst., Stellenbosch, South Africa). p.482-95 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

A series of experiments were undertaken to determine the effect of irradiation with ^{60}Co gamma rays on Penicillium expansum, Rhizopus nigricans, R. stolonifer, and Botrytis cinerea, four organisms responsible for post-harvest decay of apples, peaches, grapes, and strawberries. The results clearly indicate that although the development of the fungi was not absolutely controlled, their progress in the fruit was inhibited in various degrees. The penetration of P. expansum in both ripe and unripe apples was progressively inhibited at dosages of 293 kR and higher. A similar pattern of radial inhibition of fungal penetration was observed in peaches infected with R. stolonifer and R. nigricans. Radiation had no protective effect on grapes infected with B. cinerea 30 hours prior to treatment. Further results with grapes indicated that the effect of radiation is more promising when applied in conjunction with low temperature storage. The inhibition of B. cinerea in strawberries was less spectacular. A spore suspension of P. expansum was completely inactivated by a dosage of 200 kR while B. cinerea and R. nigricans survived a dosage of 400 kR. Total inactivity of yeast cells both in fresh grape juice with wild yeast and in clarified juice, was attained with a dosage of 489 kR. The application of radiation to inhibit sprouting of potatoes and thus prolonging the storage life of the tubers is illustrated. Irrespective of storage temperature a dosage of 44 kR applied either immediately after harvest or a month later prevented tubers of Up-to-Date and Arran Chief from sprouting over a 5 month storage period. Smaller dosages were less effective. Radiation had no marked effect on the chemical composition of either applies or potatoes. (auth)

11636 LETHAL AND STERILISING EFFECTS OF COBALT-60 GAMMA RAYS ON ARGYROPLOCE LEUCOTRETA. A. C. Myburgh (Fruit and Food Tech. Research Inst., Stellenbosch, South Africa). p.514-25 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Whereas extremely high exposure doses of gamma rays ranging from nearly 200 to 400 kR, were required to inhibit development within each respective stage of metamorphosis of Argyroploce leucotreta Meyr, exposures between 10 and 120 kR, at a radiation intensity of 80 R per minute, inhibited development of moths from immature stages. Considerably lower exposure doses, ranging from approximately 5 to 70 kR, were required to achieve sterility. The stages of metamorphosis, from egg to adult, became progressively more resistant to the effects of gamma rays, while resistance also increased with age within each stage. Males were generally more resistant than females. A direct relation between radiation intensity and magnitude of effect on the species was evident. Possible application of gamma rays for control of A. leucotreta in packed fruit and in orchards is discussed. (auth)

Power Application

11637 NUCLEAR POWER IN SPACE-RADIOISOTOPE SYSTEMS. J. G. Morse (Martin Co., Baltimore). Raumfahrtforschung, 8: 161-4(Oct.-Dec. 1964).

Radioisotope-fueled thermoelectric generators are today supplying dependable power to satellite systems. Although the technology is relatively new, it has already demonstrated long-term reliability, power-to-weight ratios that are competitive with solar cells, and independence from energy storage in batteries, natural and artificial radiation belts, and solar transients. The development of these power sources from the first unit used in space to those which promise widespread application for the next two or three years is reviewed. The work reported was performed by Martin under the USAEC SNAP Program. (auth)

11638 ISOTOPIC SOURCES OF RADIATION POWER. O. A. Kuhl and D. S. Ballantin (Brookhaven National Lab., Upton, N. Y.). p.35-84 of "Radiation Sources." New York, The Macmillan Company, 1964.

The production of sources of radiation power from radioactive isotopes, the facilities for their utilization and transportation, and the costs involved are discussed. ^{60}Co sources produced at Brookhaven National Laboratory, Chalk River, and Harwell are described and compared. ^{137}Cs sources are also discussed. Shipping containers and radiation facilities are described and diagrams shown. (M.C.G.

Separation and Production

11639 (CEA-Bib-52) SEPARATION ISOTOPIQUE DES ELEMENTS LOURDS. (Isotopic Separation of Heavy Elements). Irma Lambert (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Oct. 1964. 20p. Dep.(mn).

The methods of separating the natural isotopes of the heavy elements Hg, Tl, Pb, and U are reviewed, with the exception of electromagnetic separation, centrifuging, and gaseous diffusion. The methods are: 1. Reversible statistical processes using equilibria between two phases. 2. Irreversible statistical processes: electromigration, thermal diffusion and molecular distillation. 3. Photochemical separation in the particular case of mercury. None of these methods has given satisfactory results for lead and thallium. By photochemistry it is possible to isolate the isotopes 198 and 200 of mercury in an almost pure state. Of the many methods tried out for the $^{235}U/^{238}U$ separation, only thermal diffusion leads to marked enrichment. Chemical methods however can be used for a preenrichment before carrying out electromagnetic or thermal diffusion separations. (auth)

11640 (ORNL-P-744) A REVIEW OF THE MAGNETIC FIELD SHAPING METHODS USED IN THE DEVELOPMENT OF THE 255° OAK RIDGE ISOTOPE SEPARATOR. William Kelly Dagenhart (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract [W-7405-eng-26]. 159p. Dep.(mn); $5.00(cy), 3(mn) OTS.

Thesis submitted to Univ. of Tennessee, Knoxville.

Magnetic field shaping methods used to convert the Oak Ridge calutrons into 255° instruments are described. The 255° separators have high resolution, high dispersion, and equivalent throughput as compared to the unmodified calutrons. The performance improvement is achieved by the use of axially invariant radially inhomogeneous magnetic fields. (T.F.H.)

11641 (SGAE-PH-4/1964) BESTIMMUNG DER BILDKURVE DEI EINEM ELECTROMAGNETISCHEN ISOTOPENSEPARATOR MIT INHOMOGENEM MAGNETISCHEN SEKTORFELD. (Determination of the Image Curve of an Electromagnetic Isotope Separator With Inhomogeneous Magnetic Sector Fields). F. P. Viehboeck, H. Wotke, and F. Ruedenauer (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf; Vienna. Technische Hochschule; and Vienna. Universitat. Institut fur Theoretische Physik). [1964]. 9p. Dep.(mn).

The expressions for the image curve of an electromagnetic isotope separator were derived, and the collector plane was determined experimentally. The coordinate system of the isotope separator, the measuring arrangement in the collector chamber, and the theoretical and experimental image curves were shown. (J.S.R.)

11642 ION EXCHANGE AND OTHER METHODS FOR ISOTOPE SEPARATION. E. Roth. Bull. Inform. Sci. Tech. (Paris), No. 85, 97-100(July-Aug. 1964). (In French)

The chemical and physical methods used for the isotopic separation of rare gases, ^{3}He, ^{6}Li, Cl, ^{18}O, ^{34}S, ^{15}N, ^{13}C, ^{10}B, Hg, D, and ^{235}U are tabulated. (J.S.R.)

11643 THE SEPARATION OF ISOTOPES BY MEANS OF ION EXCHANGE RESINS. Robert Rosset, Bernard Tremillon, and H. Fould (Ecole de Physique et de Chimie, Paris). Bull. Inform. Sci. Tech. (Paris), No. 85, 101-13 (July-Aug. 1964). (In French)

The characteristics of the ion exchange method, which favor its use in some case of isotope separation, are reviewed. Isotopic separation coefficients were derived. The results obtained for nitrogen, lithium, boron, carbon, oxygen, sodium, sulfur, chlorine, calcium, iron, copper, and uranium are summarized. (J.S.R.)

11644 EFFECT OF BOUNDARY LAYER ON THE SEPARATION EFFICIENCY OF GASEOUS DIFFUSION. Hisashi Mikami and Yoichi Takashima (Tokyo Inst. of Tech.). Bull. Tokyo Inst. of Tech., Ser. B, No. 54, 99-114 (Sept. 1963).

The separation factor obtainable in a gaseous diffusion unit is usually smaller than the ideal separation factor, $\sqrt{m_2/m_1}$, owing to various effects. Among these effects, the back diffusion, deviation from free molecular flow, and the surface diffusion were studied in detail previously. In order to estimate the separation factor actually obtainable in a practical unit, it is further necessary to study the effect of the boundary layer. This was treated in detail in the cases of laminar and turbulent flow on a flat plate and of fully developed laminar flow in a pipe. (auth)

11645 CONTRIBUTION TOWARDS THE STUDY OF DEUTERIUM SEPARATING FACTORS BETWEEN AMMONIA AND HYDROGEN. B. Lefrancois and Y. Bourgeois. Genie Chim., 91: No. 5, 138-49(May 1964).

The implementation of the method of producing heavy water through deuterium exchange between ammonia and hydrogen calls for precise knowledge of the various separating factors between these two bodies. A very small error in this factor can lead to significant variations in the dimensions of the industrial contact towers. All of the physical measurements required for computing these factors are presented. (auth)

11646 A METHOD FOR PRODUCING CHROMIUM-51. C. H. Tsai and H. J. Yeh (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 71-7(Feb. 1964). (In Chinese)

A method was developed for producing ^{51}Cr in high concentration by means of the (n,γ) reaction. It involves the precipitation of $^{51}Cr(OH)_3$ from a $KCrO_4$ solution at a pH of 7.6 to 7.8, exposed to a neutron beam. The resulting product had a high enrichment factor and high specific activity. The gamma spectrum of the product agreed with the standard gamma spectrum of ^{51}Cr. (TTT)

11647 PRODUCTION OF ^{24}Na AND ^{42}K ISOTOPES IN THE RESEARCH REACTOR OF THE TSING-HUA UNIVERSITY. J. D. Chang and T. F. Chen (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 79-80(Feb. 1964). (In Chinese)

The problems arising from the production of ^{24}Na and ^{42}K in the research reactor of the Tsing-Hua University are reviewed. High-purity (99%) $NaHCO_3$ and $KHCO_3$ were used as target materials. Both of these materials are fairly radiation resistant and do not decompose during the exposure. The ultimate product is prepared by dissolving the irradiated materials in distilled water and adding 0.1 N HCl to neutralize the solution. The isotopes obtained have been used with good success in medical and biological experiments. However, the specific activity is lower than desired, and studies are under way to increase the specific activity. (TTT)

11648 NITRIC OXIDE DISTILLATION PLANT FOR ISOTOPE SEPARATION. B. B. McInteer and Robert M. Potter (Los Alamos Scientific Lab., N. Mex.). Ind. Eng. Chem., Process Design Develop., 4: 35-42(Jan. 1965).

A plant for enriching oxygen and nitrogen isotopes by NO distillation, consisting of a purifier unit, a staged column 575 cm long for continuous flow, and a uniform column for final batchwise enrichment, was built and successfully operated. Over 600 (STP) liters of enriched NO were produced, with an average composition of 1.5% ^{17}O, 21% ^{18}O, and 25% ^{15}N. Enrichments as large as 8.3% ^{17}O, 98.2% ^{18}O, and 93.9% ^{15}N were attained. Technological developments in low temperature distillation and purification of nitric oxide are described. Exchange reactions among the isotopic species are negligibly slow in these columns. (auth)

11649 PREPARATION OF ^{24}Na OF VERY HIGH SPECIFIC ACTIVITY. K. H. Neeb (Siemens-Schuckertwerke AG, Erlangen, Ger.). Nukleonik, 6: 320-2(Oct. 1964). (In German)

By heating neutron-activated aluminum metal in flowing water at 1100°C the ^{24}Na activity formed by means of the (n,α) reaction can be separated in a simple way. By carrying out the reaction in a quartz tube lined with molybdenum the gaseous ^{24}Na could be dissolved out with dilute acid. After 3-hr neutron activation of the aluminum with a flux of 5×10^{12} n/cm^2 sec and using the method described, ^{24}Na

with a specific activity of 5 to 10 C/g and a radiochemical purity of over 99.9% can be obtained. (tr-auth)

11650 THE DEVELOPMENT OF A COBALT-60 RADIATION SOURCE. Erich Walter (Siemens-Halske AG, Erlangen, Ger.). Roentgen-Lab. Praxis, 16: 127-31(June 1963). (In German)

Very pure Co was used as a starting material for preparation of a high-energy source. It was formed into pellets, which were plated with Ni to prevent fragmentation. The pellets were placed in an Al capsule, which was then attached, along with other, similar capsules, to an Al tube. The tube was positioned in an optimal channel within a reactor for irradiation. For activation to ~100 C/g, irradiation had to continue for several months. At the end of the activation period the capsules were removed from the reactor with adequate radiation protection precautions. The Al capsule was either milled off by remotely controlled instruments, or dissolved away by an alkali, which did not affect the Ni or the Co. After a washing procedure the radioactive pellets were ready for use. Because of legal requirements and the danger of possible defects in the capsule, packaging required great care. The sources were encased in a double welded container, composed of stainless steel, before being shipped. The welding was carried out under an inert gas so that the weld juncture would be corrosion free. Finally, the source package was tested for proper construction and strength, the source intensity was measured, and it was placed in a radiation device or shipping container. It could be transported without special precautions, because the container was constructed so that it conformed to all international safety regulations specified for a radiation source of this type. (BBB)

11651 D_2O PRODUCTION BY LOW PRESSURE, PERIODIC RECTIFICATION. Alicja Dorabialska and Witold Swiatkowski (Lodz Technical Univ., Poland). Zeszyty Nauk Politech. Lodz., Chem., 12: 61-7(1962). (In Polish)

A rectification column for the enrichment of natural H_2O in D_2O was constructed. The column works periodically, at low pressure. The time required for the establishment of equilibrium in the column was determined. The effects of composition of rectified water on the separation column, reflux coefficient, and pressure were investigated. As convenient operation conditions the pressure of 38 mm Hg and reflux coefficient about 18 were assumed. It was found that for the efficient rectification low pressure and high reflux coefficient are required. (auth)

11652 THE SEPARATION OF HEAVY ISOTOPES IN A CENTRIFUGAL FIELD. Johannes Los. Thesis, Leiden, Netherlands, Rijksuniversiteit te Leiden, 1963. 98p. (In Dutch)

Experimental and theoretical work on centrifuges is reviewed along with centrifuge cascade theory. Theory of countercurrent centrifuges is examined and profiles of the countercurrent are presented to showing the loss in separative power caused by discrepancies between optimal and actual flow patterns. (J.R.D.)

11653 LIQUID ENTRAINMENT SEPARATOR FOR U_3 (Engineering Materials). (Oak Ridge National Lab., Tenn). (CAPE-1119)

The entrainment separator is used to remove mist from exhaust vapors of an evaporator. The 12¼-in.-ID, 42-in.-long, stainless steel vessel consists of a vapor inlet distribution section, a section packed with ⅝ in. glass Raschig rings, and a vapor outlet section. The Raschig rings contain ~4 wt % of B which is the neutron absorbing material; thus making the unit nuclearly safe for the highly enriched U solutions (up to 93.2% ^{235}U) found in diffusion plant operation. (J.R.D.)

11654 AN IMPROVED METHOD OF SEPARATING HYDROGEN ISOTOPES. Alan Sydney Darling (to Johnston, Matthey and Co. Ltd.). British Patent 973,820. Oct. 28, 1964. Filed Nov. 30, 1962.

An improved method is reported for the separation of H_2 isotopes for the manufacture of D_2 as heavy water. The method involves electrolysis of a suitable electrolyte or electrolytic migration using a hydrogen diffusion element formed of a Pd-Ag alloy (5-30% Ag, balance Pd). Using the preferred experimental conditions for the electrolysis of a 1% H_2SO_4 electrolyte with a 25% Ag–Pd membrane at an operating temperature of 80°C and a current density of 0.05 amp/cm², hydrogen diffusion efficiencies of about 95% are reported. The permeability of the Ag–Pd diffusion element is substantially equal to that of an element formed of pure Pd, but the tendency of the element to undergo distortion is considerably less and the operating life of the improved diffusion element is greatly increased. (A.G.W.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 11563 and 12349.

11655 (EUR-2160.e) STUDIES AND DEVELOPMENT OF BUFFER STORAGE SYSTEMS FOR NUCLEAR EXPERIMENTS. W. Stueber (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium). 1964. 47p. Dep.(mn).

Some introductory remarks on the use of buffer stores in data handling systems for nuclear measurements are made. Considerations and calculations on the tolerable dead-time and the necessary size of buffer stores in relation to time-of-flight experiment conditions are presented. Rules and curves for the spectrum distortions caused by buffer stores are given. Two buffer stores, designed for the experiment conditions, are described briefly. The two stores, a 10-word ferrite-core store with a cycle time of 2 μs, and a 3-word tunnel-diode store having a cycle time of 0.1 μs, can be combined. Loss curves measured with the ferrite-core store are discussed. (auth)

11656 (HW-66216) EXPERIMENTAL DIGITAL CONTROL COMPUTER-STUDY REPORT. R. A. Harvey, N. P. Wilburn, J. W. Finnigan, E. T. Merrill, and R. C. Burke (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 17, 1960. Contract AT(45-1)-1350. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The applications of a digital experimental-control computer include: investigations of analog and digital techniques for use in continuous process control systems; data handling systems; data presentation; and telemetering of computer information. Studies are presented of applications, equipment requirements, scheduling problems, and funding aspects for such a control computer. (T.F.H.)

11657 (NYO-1480-2) ACTIVITIES OF THE ENGINEERING RESEARCH LABORATORY, JULY 1, 1963–JUNE 30, 1964. (New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center). Aug. 1, 1964. Contract AT(30-1)-1480. 222p. Dep.(mn); $6.00(cy), 4(mn) OTS.

Memory research and related activities are covered. Accounts are given of the following projects: Diode-select computer memory (to be used in a time-of-flight analyzer), design and construction of a memory unit, nondestructive memory mode and model, design of an engineering test computer to be built for testing memories, a memory exerciser, sense amplifier design, thin-film work, an automatic core-threading device, and machine recognition of handwritten or printed alpha-numeric characters. (D.L.C.)

11658 (JUL-174-MA) UBERSETZUNG FORMALER SPRACHEN IN TOPOLOGISCHE STRUKTUREN. (Translation of Formal Speech in Topological Structures). Walter Petry (Mainz. Universität. Institut für Angewandte Mathematik). Sept. 1964. 69p. Dep.(mn).

For the translation of formal speech into topological structures, the elements of speech, the construction of expressions from the elements, the concept of the relation, and the permitted transformation rules for relations are given. The concept of elementary systems, recoupled systems, and permitted systems are introduced. Elementary or recoupled systems are constructed from mathematical or topological symbols. Limitations of the basic speech are determined. A topological solution of a completely permitted system, which is written in a commutative operative speech with inverse operators, is constructed. The distinctive object of a system is determined, and the inverter is minimized. Two programs for the translation process are given. (J.S.R.)

11659 A NOTE ON INVARIANT IMBEDDING AND GENERALIZED SEMIGROUPS. Richard Bellman and Thomas A. Brown (RAND Corp., Santa Monica, Calif.). J. Math. Anal. Appls., 9: 394-6(Dec. 1964).

A system of differential equations arising from a one dimensional transport process is considered. Generalized semigroup relations are derived and used to extend the region of solution of the transport equations, thus defining the precise region in which a unique solution exists. A case is considered for which, if a unique solution does not exist, a shock is obtained. (M.J.T.)

11660 DRIFT—A DRIFT-CORRECTING COMPUTER SUBROUTINE FOR NUCLEAR SPECTROSCOPY. P. Paatero (Univ. of Helsinki). Nucl. Instr. Methods, 31: 352 (Dec. 21, 1964).

A FORTRAN subroutine DRIFT is presented, which automatically shifts and stretches spectra to be added together, so that two preselected peaks fall into predetermined channels. (M.J.T.)

11661 ISOMETRIC EMBEDDING OF RIEMANNIAN MANIFOLDS INTO EUCLIDEAN SPACES. Avner Friedman (Northwestern Univ., Evanston, Ill.). Rev. Mod. Phys., 37: 201-3(Jan. 1965).

Differential geometry results pertaining to the problem of embedding curved space–time in a pseudo-Euclidean space are reviewed. (auth)

11662 EMBEDDING OF VARIOUS RELATIVISTIC RIEMANNIAN SPACES IN PSEUDO-EUCLIDEAN SPACES. Joe Rosen (Tel-Aviv Univ., Israel). Rev. Mod. Phys., 37: 204-14(Jan. 1965). (IA-937)

The embedding of various relativistic Riemannian spaces is performed. In each case the original Riemannian line element, the embedding pseudo-Euclidean line element, and the embedding transformation are shown. (auth)

11663 GENERALIZED COVARIANCE. D. W. Joseph (Univ. of Nebraska, Lincoln). Rev. Mod. Phys., 37: 225-7 (Jan. 1965).

The embedding of space–time in a higher-dimensional pseudo-Euclidean space is considered as a means of studying the representations of coordinate transformations in curved space–time. To the extent that this approach is valid, the existence of particles belonging to various representations of some internal symmetry group is predicted in much the same sense that particles of spin 0, $\frac{1}{2}$, 1, etc. are predicted by the structure of representations of the Lorentz group. (auth)

11664 PROCEEDINGS OF A SYMPOSIUM IN APPLIED MATHEMATICS OF THE AMERICAN MATHEMATICAL SOCIETY HELD IN NEW YORK CITY, APRIL 30–MAY 2, 1963. Richard Bellman, ed. Stochastic Processes in Mathematical Physics and Engineering. Proceedings of Symposia in Applied Mathematics. Volume XVI. Providence, American Mathematical Society, 1964. 325p. (CONF-630401)

Elements of the theory of stochastic equations are presented, including particular equations arising in wave propagation and scattering theory. Perturbation techniques, closure, stochastic iteration, probability bounds, and sequential decision processes are considered; and classical estimation and identification problems arising from stochastic processes are treated. Deterministic equations associated with random walk, turbulence, and diffusion theory are also considered. (D.C.W.)

11665 LECTURES ON LIE GROUPS. G. Racah (Hebrew Univ., Jerusalem). p.1-36 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

Principles of Lie groups are outlined, including notion on continuous groups, classification of Lie groups, classification and representation of semisimple groups, vector diagrams, and classification and construction of the irreducible representations of semisimple groups. The representations of SU(3) reduced with respect to the three-dimensional rotation group R_3 are considered. (D.C.W.)

11666 CONTRACTION OF LIE GROUPS AND THEIR REPRESENTATIONS. E. Inoenue (Univ. of Ankara). p.391-402 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

The contraction of a Lie group through a limit operation is defined and outlined, and the effect of the operation on representations of the group are considered. Two methods for obtaining faithful representations are demonstrated. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General

11667 (D2-20282-1) DEVELOPMENT AND EVALUATION OF C-129Y (Cb-10W-10Hf-0.1Y) COLUMBIUM ALLOY. R. T. Torgerson (Boeing Co., Seattle). Mar. 20, 1964. 36p.

Studies on modification of Nb–W–Hf alloys with yttrium additions have led to the successful development of C-129Y alloy with the composition Nb–10W–10Hf–0.1Y. This alloy, which is a modification of C-129 (Nb–10W–10Hf), exhibits superior weld ductility but retains the excellent strength and formability of C-129 alloy. Properties evaluation of C-129Y alloy sheet has shown good strength at temperatures to 3500°F, excellent formability, excellent weldability, and sub-zero ductile-brittle transition temperature. Tensile data indicate C-129Y has equal strength to C-129 except in the temperature range of 2000° to 3000° where C-129Y appears to be about 5 percent lower in strength. Tentatively, this strength difference is attributed to the effect of a slightly higher level of interstitial impurities in C-129. Tungsten-arc welds of C-129Y display ½T minimum bend radius in the as-welded condition compared to 8T for C-129 alloy. Tensile tests of welded C-129Y revealed a joint efficiency of 100 percent. Investigation using the Disil coating process has demonstrated coating compatibility of C-129Y and good oxidation protection at temperatures to 3000°F. Glide re-entry flight-profile simulator tests to 2800°F have been successfully conducted on Disil coated C-129Y with and without a TiC high emittance topcoat. The Disil coating does not adversely affect the strength or ductility of C-129Y sheet material. However, the Disil coating significantly lowers the bend and tensile ductility of fusion welds of C-129Y at room temperatrue. This factor should be taken into consideration in design of high temperature structures. The excellent combination of strength, fabricability, weldability, and low transition temperature of C-129Y offers potential design advantages for use of this alloy in structures of aerospace vehicles. It is anticipated that C-129Y will rapidly supplant C-129 and similar alloys due to the versatility provided by its improved welding properties. (auth)

11668 (DP-945) HEAVY WATER MODERATED POWER REACTORS. Progress Report, November–December 1964. R. R. Hood, comp. (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). Jan. 1965. Contract AT (07-2)-1. 28p. Dep.; $2.00(OTS).

Operation of the Heavy Water Components Test Reactor was terminated on December 1, as the result of a decision by the USAEC to curtail its development program on D_2O-cooled power reactors. The facility is being placed in standby condition. Ten-ft-long Zircaloy spacing ribs were attached successfully to the inside surface of Zircaloy housing tubes by electron beam welding. The buckling that was observed in an unalloyed uranium tube at 6830 Mwd per metric ton was attributed to cavitation swelling. Corrosion coupons of various materials that were exposed to hot D_2O in the HWCTR were examined. (auth)

11669 (GEMP-41A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 41, PART A. (General Electric Co. Advanced Technology Services, Cincinnati). Nov. 30, 1964. Contract AT(40-1)-2847. Dep.; $3.00(OTS).

Metallographic and electron-microprobe analyses of Fe–Cr–Al–Y–clad Cr–UO_2 capsule specimens tested at 1100°C for 3000 hours revealed mild interdiffusion of the core and cladding elements and, within the detection limit (500 ppm) of the electron microprobe analysis, no diffusion of U. Capsule specimens of 2541-clad Fe–50UO_2 exceeded 3600 hours at 1100°C in air and show no visual evidence of fuel penetration of the cladding. Impact test results on the Fe–Cr–Al–Y alloys indicate that the ductile-to-brittle transition temperature is 140°C for the 2541 alloy, 170°C for the 1541 alloy, and 200°C for the 0561 alloy. A specimen of 2541 alloy stressed at 140 kg/cm^2 at 650°C showed 0.4% creep in 5765 hours. Welds in the 1541 alloy after 500 hours at 1100°C were as good in respect to oxidation resistance and ductility as that of the base metal. Tests of 2541 alloy conducted at GE-APED in high-velocity superheated steam at 620°C for 5000 hours show the corrosion resistance of this alloy to be better by a factor of four than Incoloy 800. The tensile strength and hardness of 2541 alloy were unaffected by this long exposure. Stress-rupture and creep data for wrought, sintered Mo–50Re were obtained at 1600°C in H_2. The stresses to produce rupture in 1, 10, and 100 hours were 4.4, 2.7, and 1.7 kg/mm^2, respectively. The time-to-rupture for Mo–50Re at 1600°C is approximately an order of magnitude greater than that for pure Mo in the stress range of 2 kg/mm^2. Lap joints of Ta–10W brazed with pure V or Nb–40V, and W–25Re brazed with Nb–40V, had a stress-rupture life in H_2 at 1600°C and 7.03 kg/mm^2 equal to the base metal. Creep-rupture testing of W specimens at 900°C (0.32T_m) shows that the as-irradiated and the irradiated-plus-annealed specimens have a longer rupture life than unirradiated specimens. Annealing the irradiated specimens at temperatures up to 1200°C results in increases in rupture life over and above that observed for the specimens in the as-irradiated condition. Further annealing at temperatures up to 1700°C results in rupture life increases which are still greater than those of the control specimens but less than that of the as-irradiated specimens. Irradiated Mo specimens show a significant acceleration in creep rate when tested at temperatures below 0.31 T_m. When similar irradiated specimens were annealed above 0.31 T_m for 1 hr and then creep-rupture tested below this temperature, there was an increase in the time-to-rupture compared with data of the control specimens. Computer studies on vacancy production in neutron irradiated α-Fe show the displacement density. Five curves are presented which show the density of single vacancies, di-vacancies, tri-vacancies, total vacancies, and clusters consisting of 10 or more vacancies. A positive error of approximately 100°C may be expected in W/W–25Re thermocouples in a relative short exposure time (1 month at 10^{14} thermal neutron flux) due to transmutation. The electrical resistance of ThO_2 was approximately a factor of 10 lower in H_2 than in He at temperatures up to 2500°K. (auth)

11670 (HW-83604) PROGRESS IN GRAPHITE RESEARCH. A Summary of Hanford Laboratories Achievements in This Program Under General Electric, 1956–1964. R. E. Nightingale (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1964. Contract AT(45-1)-1350. 35p. Dep.; $2.00(OTS).

The accomplishments of graphite research at Hanford are summarized with emphasis on the period from 1956 to 1965. Radiation damage, neutron dosimetry, and gas-graphite reactions are considered in detail. Cooperative efforts with several carbon companies and technical exchanges with foreign countries are discussed. (D.L.C.)

11671 (NRL-6119) EFFECT OF ELECTRON BOMBARDMENT HEATING ON SURFACES OF TUNGSTEN. H. Doering and P. Shahinian (Naval Research Lab., Washington, D. C.). May 15, 1964. 15p. (AD-604170). $0.50 (OTS).

Heating to very high temperatures by electron bombardment often roughens (or damages) metal surfaces. This damage to grain boundaries and grain surfaces is examined in electropolished sheet and foil specimens of tungsten. The effects of heating by stationary and oscillating 10-kv beams are compared with the effects produced by thermal radiation. At moderate temperatures, stationary beams induce grain boundary grooving as does thermal radiation, while oscillating beams produce ripples in the surface. At high

temperatures, stationary beams and thermal radiation produce pits, while oscillating beams produce cracks, and tilted and dislodged grains. The more severe effects produced by oscillating beams are shown to be associated with thermal cycling. (auth)

11672 (ORNL-3723) IMPACT RESISTANCE OF FUELED GRAPHITE SPHERES FOR PEBBLE-BED REACTOR APPLICATIONS. C. O. Smith and J. M. Robbins (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 69p. Dep.; $3.00(OTS).

A program to develop a fuel sphere to meet the requirements for the German Pebble-Bed Reactor (AVR) focused attention on the machined-shell concept in which a premolded spherical fuel insert is cemented in the premachined, fully graphitized, unfueled shell. Two studies were undertaken: (1) evaluation of impact resistance of commercially available graphite for the shell and (2) determination of the minimum shell thickness required and the effect of insert-shell gaps, which could be present initially or develop during reactor operation. In the initial study, 1.5-in.-dia spheres, machined from four grades of extruded graphite and four grades of molded graphite, were dropped from 13 m onto a steel plate until failure. Grade ATJ graphite was clearly the best and was used almost exclusively in further tests. In the fueled-sphere tests, simulated elements (the fueled portion simulated by a sphere of solid CS-312 graphite) were dropped from 4 m onto a bed of graphite spheres until failure or 75 drops, whichever was less, followed by dropping of surviving elements from 4 m onto a steel plate to failure. The results are: (1) The effects of preassembly cleaning and variations in plug-closure torques between 15 and 50 in.-lb and in types of cements (P-514, C-10, and Hexalon) are negligible. (2) Elements with uncemented inserts are clearly inferior to elements with completely cemented inserts. (3) Shells with 0.8-cm-thick walls are satisfactory for nominal radial clearances between insert and shell of 0.005 to 0.010 in., but 1.0- to 1.2-cm-thick shells would be required for clearances of 0.020 to 0.025 in. (D.L.C.)

11673 (ORNL-TM-1004) STRESS-RUPTURE TESTING OF EGCR FUEL TUBES. J. T. Venard (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Stress-rupture tests have been run on internally pressurized type 304 stainless steel tubes. These specimens were cut from production EGCR fuel-clad tubes after the copper brazing of midplane spacers. Testing was performed at temperatures of 593, 704, 816, and 982°C, which is the expected range of operation of these fuel elements. Results show the strength and ductility properties expected of type 304 stainless steel. There was no loss in strength due to the presence of the copper braze metal or the spacers. No abnormal grain growth occurred during brazing or testing, and results were the same on testing in flowing argon or air atmospheres. (auth)

11674 ISSLEDOVANIYA PO ZHAROPROCHNYM SPLAVAM. TOM X. (Investigations of High-Melting Alloys. Volume X). Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 1-316(1963). Moscow, Publishing House of the Academy of Sciences, 1963.

Fifty-eight papers are presented on mechanical properties and oxidation kinetics of high-melting alloys. Separate abstracts were prepared for four papers of special interest. Two papers appeared previously in NSA (abst. 18: 34079 and 34080). (R.V.J.)

For abstracts of individual papers see: 11693, 11738, 11739, and 11740.

11675 IMPERMEABLE GRAPHITE FOR HIGH TEMPERATURE USES PRODUCED BY SEVERAL NOVEL METHODS. Shigehiko Yamada (Tokai Electrode Mfg. Co., Ltd., Nagoya, Japan). Kagaku Kogaku, 16: 16-22 (1963). (In Japanese)

Improved methods are described for making heat-resistant impermeable graphite for use in reactors. (BBB)

11676 PERFORMANCE OF NEW MOLYBDENUM-BASE ALLOY TOOLS IN CASTING PROCESSES. Russell W. Burman (Climax Mollybdenum Co., Detroit). Mod Castings, New Technol. Sect., 46: 471-80(Aug. 1964)—Trans. Am. Foundrymen's Soc., 72: (1964).

The performance potential of a new Mo-base alloy was evaluated and tested. It has been found to have resistance to heat checking and soldering, resistance to wash and erosion, and resistance to softening and deformation. Heat treatment of the alloy is not necessary as it conforms to the nonferrous metallurgical strengthening processes in which cold working is the principal hardening mechanism. It displays good notch toughness under slow strain rates at temperatures below room temperature. Field experience reports of the alloy have been good, and the material has many potential applications. (auth)

11677 PRODUCTION OF URANIUM, THORIUM, AND PLUTONIUM AND THEIR COMPOUNDS. Reactor Fuel Process., 7: No. 2, 146-56(1964).

Research is reported on the recovery of uranium from ores, production of uranium oxides, production of uranium carbides and nitrides, production of uranium metal, recovery of uranium from refinery wastes, and thorium production. (40 references). (M.C.G.)

11678 REACTOR MATERIALS. Volume 7, Number 4. R. W. Dayton, E. M. Simons, and R. W. Endebrock (Battelle Memorial Inst., Columbus, Ohio). Winter 1964–1965. $0.70(GPO) (Domestic), $0.90(GPO) (Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

Technical progress on reactor materials is reviewed under the following topics: fuel and fertile materials, moderator materials, nuclear poisons, cladding and structural materials, and special fabrication techniques. Separate abstracts were prepared for each of the 5 topics. (M.C.G.)

For abstracts of individual chapters see: 11679, 11680, 11681, 11692, and 11711.

11679 FUEL AND FERTILE MATERIALS. Reactor Mater., 7: 211-29(Winter 1964–1965).

Research progress is reported on uranium metal and alloys, plutonium, thorium metal-ceramic fuels, coated-particle fuel materials, uranium oxides, uranium and thorium carbides, uranium and thorium nitrides, uranium and thorium sulfides, fuel-water reactions, and basic studies of irradiation effects in fuel materials. (66 references). (M.C.G.)

11680 MODERATOR MATERIALS. Reactor Mater., 7: 230-5(Winter 1964–1965).

Research progress on graphite, beryllium and its alloys, beryllium oxide, beryllium intermetallic compounds, and solid hydrides is reviewed. (22 references). (M.C.G.)

11681 NUCLEAR POISONS. Reactor Mater., 7: 236-7 (Winter 1964–1965).

Research on metallic and dispersion poison materials is reviewed. (8 references). (M.C.G.)

11682 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 7: 238-56(Winter 1964–1965).

Research progress on corrosion, metal-water reactions, mechanical properties of refractory materials, metallurgical aspects of cladding and structural materials, diffusion, ceramic technology, and radiation effects in nonfuel materials is reviewed. (91 references). (M.C.G.)

11683 THE HEATING AND MELTING OF SOME REFRACTORY OXIDES WITHOUT CRUCIBLES. Monique Perez y Jorba and Robert Collongues (C.N.R.S., Vitry, France). Rev. Hautes Temp. Refractaires, 1: 21-5(Jan.-Mar. 1964). (In French)

ZrO_2 stabilized by addition of lime or rare-earth oxides is a semi-conductor. Heating of this material by the Joule effect has already been considered but the current-leads represent a difficulty. Therefore the induction-heating of this material has been considered. Using a frequency of 20 Mcs, the depth of penetration of the induced currents is about 1 to 3 cm for a sample preheated between 1,200 and

1,600°C. Under these conditions, samples are immediately melted. Furthermore, the thermal conductivity of zirconia being extremely low, the outer layers of the sample remain solid. Tapping can be achieved through a hole made in the bottom of the cylinder. Other refractory oxides were melted under the same conditions, notably CeO_2 and TiO_2. In this case the non-stoichiometric phase $TiO_2-\epsilon$ obtained after a first melting, has sufficient electrical conductivity to be remelted without previous preheating. (auth)

11684 MELTING OF URANIUM DIOXIDE BY DIRECT HIGH-FREQUENCY INDUCTION. B. Gayet, J. Holder, and G. Kurka (Commissariat à l'Énergie Atomique, Ballancourt-sur-Essonne, France). Rev. Hautes Temp. Refractaires, 1: 153-7(Apr.-June 1964). (In French)

The principle of melting by high-frequency induction (5 Mc) in the case of refractory compounds that are non-conducting at room temperature is briefly reviewed. Owing to its poor thermal conductivity and to the high energy radiated at the melting temperature, the molten material forms its own crucible. The apparatus for melting UO_2 (melting point 2,800°C) is described. This new method makes it possible to prepare monocrystals of UO_2 the density of which is near the theoretical density (theoretical value: 10.96) and this without foreign bodies because there is no contact with any other material. This type of nuclear ceramic fuel has technical and economic advantages over fuel elements made by the usual densification method (sintering of pellets); after grinding, this material can undergo direct compaction by vibration in the casing. (auth)

11685 PREPARATION OF SINTERABLE BERYLLIUM OXIDE THROUGH DECOMPOSITION OF HYDROXIDE. M. Bernier (Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, France). Rev. Hautes Temp. Refractaires, 1: 239-60(July-Sept. 1964). (In French)

The factors which affect the preparation of the beryllium hydroxide and oxide and during the sintering have an effect on the density and homogeneity of the sintered body are investigated. Of the several varieties of hydroxides precipitated from a sulfate solution only β-hydroxide is always contaminated with beryllium sulfate and cannot be purified even by thorough washing. It was noticed that thoses varieties of the hydroxide (gel, α, β) have different decomposition rates; this behavior is used to identify and even to dose the different species in (α,β) mixtures. The various hydroxides transmit to the resulting oxides the shape they had when precipitated. Accordingly the history of the oxide is revealed by its behavior during its fabrication and sintering. The results of the sintering operation and the various measurements performed on the oxide powders indicate that an oxide obtained from Be hydroxide is sinterable under vacuum. (auth)

11686 THE IMPORTANCE OF VACUUM TECHNIQUES FOR THE PREPARATION AND PROCESSING OF HIGH-MELTING METALS. R. Palme (Metallwerk Plansee AG, Reutte/Tirol, Austria). Vakuum-Tech., 13: 229-32(Dec. 1964). (In German)

Even comparatively small admixtures of elements with small atomic radius, such as oxygen, nitrogen and carbon, which form embedments of mixed crystals in the cubic centered structures of high-melting metals lower the mechanical properties of these metals substantially. The temperature treatments necessary for production and manufacturing of high-melting metals therefore should be performed in a very clean atmosphere. The various possibilities offered by vacuum technique in the production of pure metals are discussed. (auth)

11687 ON THE DISLOCATION ETCH-PITS IN TUNGSTEN SINGLE CRYSTALS. Nay-ben Ming, Kwan-ming Jeh, and Duan Fong. Wu Li Hsueh Pao, 20: 1182-6(Nov. 1964). (In Chinese)

11688 METHOD OF HEAT TREATING TUNGSTEN WIRE OR RIBBON. Edmond C. Hurst (to U. S. Atomic Energy Commission). U. S. Patent 3,165,427. Jan. 12, 1965.

A method of heat treating pure W wire or ribbon is described. The method comprises placing the W wire or ribbon in an evacuable chamber together with a metal member spatially mounted adjacent thereto. The chamber is then evacuated and an a-c current is applied to the W. The a-c current is gradually increased until the temperature of the W is just under its melting point, where the value of the a-c current is maintained. A d-c voltage is then applied between the member and the W being positive and the member negative. The a-c current and the d-c voltage are maintained applied to the W and the member for a predetermined interval after which the a-c current is gradually decreased to zero amperes and the d-c voltage is removed. The polarities of the member and the W are then reversed with the d-c voltage being applied thereto. The a-c current is increased until rated heater current for the W is flowing. The d-c voltage is then increased in value until maximum emission is obtained from the W. The d-c voltage, a-c current, and partial vacuum are then removed. (AEC)

11689 METHOD OF OBTAINING DUCTILE ZIRCONIUM AND TITANIUM. L. A. Nisel'son. Russian Patent 87,007.

A method of obtaining ductile Zr and Ti by means of thermal decomposition of the iodides of the indicated elements is proposed where deposition of Zr or Ti is done on a warm, induction-heated body. (auth)

Corrosion

Refer also to abstract 12150.

11690 (EURAEC-1213) QUARTERLY SUMMARY [REPORT] No. 9 [ON CORROSION OF STAINLESS STEELS UNDER STRESS], JULY 1–SEPTEMBER 30, 1964. G. Chaudron [France. Centre National de la Recherche Scientifique, Paris]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 085-62-7-RDF. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Experiments were carried out in an autoclave on the corrosion of industrial and high-purity 18-10 stainless steels in water–steam under pressure at 400°C. The results show that the industrial steel is corroded less than the high-purity steel, and that this impurity effect is increased by pressure. The intergranular attack of the stainless steels in boiling HNO_3 with Cr^{6+} added was also investigated. It was found that the high-purity 18-10 steel was not subject to this type of attack unless 1% Si was added. Martensite in high-purity steel increased the general corrosion rate. Superhardening increased the corrosion resistance of industrial steel. (D.L.C.)

11691 (EURAEC-1221) STUDY OF ELEMENTARY CRACKING, PRELIMINARY STUDY OF WELDING PROCEDURE PROTOTYPE TESTS. Quarterly Report No. 7, July 1–September 30, 1964. H. Granjon (Institut de Soudure, Paris). Nov. 23, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 090-62-12 RDF. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Thermal peculiarities of submerged-arc welding are being tested. The difference observed in the hardness in the heat affected zone between the zone situated in the bead axis and the side zones situated at right angles to the point of inflexion of the bonding zone had led to seeking and demonstrating a difference in the thermal cycle. The difference was confirmed by recordings obtained simultaneously at two points on the same straight section of the submerged-arc bead. Examination of several cross sections made on test beads showed cracks occurring in various positions. (N.W.R.)

11692 (MSAR-64-144) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 51, November 1964. (MSA Research Corp., Callery, Penna.). Dec. 15, 1964. Contract AT(11-1)-765. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The creep, creep-rupture, and fatigue properties of type 304 and 316 stainless steel are evaluated in air, helium, and sodium containing high contents of carbon and

oxygen at 1200°F. The fatigue life of type 316 stainless steel in air and helium after short-time exposure to high carbon and oxygen sodium shows a significant reduction in the number of cycles to failure as compared to similarly exposed specimens in low oxygen sodium. At high carbon and oxygen sodium exposures, creep-rupture life increases and ductility decreases. Some differences observed between types 304 and 316 stainless steel include high carburization rates, greater carbon case depths, higher microhardness values, and the formation of a ferrite phase by the removal of chromium from solution by precipitation as the carbide. Fatigue runs on type 304 stainless steel were completed at 1200°F in air and high oxygen sodium at 2.5% strain with average failures of 271 cycles in the air and 128 cycles in the sodium. (N.W.R.)

11693 OXIDATION KINETICS AND MECHANISM OF NIOBIUM–MOLYBDENUM ALLOYS. D. A. Prokoshkin, E. V. Vasil'eva, and A. M. Ryabyshev. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 233-9 (1963). (In Russian)

Tests were performed in order to determine the influence of up to 50 wt % Mo on the rate of Nb oxidation in air at 1000 to 1200°C. Minimum oxidation was observed in alloys with 10 wt % Mo at 1000°C. At higher temperatures and increased amounts of Mo the oxidation tended to increase due to the formation of volatile MoO_3, which evaporated from the scale at 1000 to 1200°C. No MoO_3 was found in the scale structure at 1000 to 1200°C. (R.V.J.)

11694 CORROSION OF MAGNESIUM ALLOY CLADDING IN SPENT FUEL COOLING POND. Goro Ito and Seiichi Ikeda (National Research Inst. for Metals, Tokyo). Nippon Genshiryoku Gakkaishi, 6: 694-9(Dec. 1964). (In Japanese)

To study the corrosion of magnesium alloy cladding in a spent fuel cooling pond, the effects of pH, the temperature of the water, and contact with dissimilar metals were investigated. The results showed that the general corrosion of magnox A-12 alloy in tap water and the occurrence of pitting corrosion can be suppressed by keeping the pH of the water higher than 12 by the addition of caustic soda, and that the contact corrosion of magnox with zirconium or stainless steel can be inhibited by increasing the pH of the water. This inhibitive action of alkali additions to the water was not affected by the dissolution in it of small amount of carbon dioxide from the air or of chloride salt from sea water. Though the corrosion rate of magnesium alloy was increased appreciably by increasing the temperature from 20 to 70°C, the penetration rate even at 70°C was only 0.04 to 0.06 mm/6 months and pitting corrosion was not observed. (auth)

11695 CORROSION OF REFRACTORIES IN THE PRESENCE OF POTASSIUM SEEDED COMBUSTION GASES. A. Dubois and M. Hamar (Compagnie Générale d'Electricité, Marcoussis, France). 9p. (CONF-640701-78). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The corrosion of refractories with an Al_2O_3 or ZrO_2 base in the presence of potassium-seeded combustion gases was studied. The experimental apparatus and procedures are described. The results showed that the materials could be classified in the order of increasing resistance: very pure fritted aluminum, porous composition of alumina and lime, porous compounds with zirconia base, and limes with high zirconia content. (J.S.R.)

Fabrication

Refer also to abstracts 11331 and 12798.

11696 (BMI-X-327) DEVELOPMENT OF FABRICATION PROCEDURES FOR THE AARR FUEL PLATES. D. S. Acuncius, D. E. Lozier, D. E. Kizer, and D. L. Keller (Battelle Memorial Inst., Columbus, Ohio). Feb. 1, 1965. Contract W-7405-eng-92. 43p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

An investigation was conducted of fabrication procedures for a 37 wt % UO_2 — stainless steel dispersion clad in stainless steel for use in the Argonne Advanced Research Reactor. Fuel core homogeneity, compaction and sintering, billet preparation, roll bonding, cold rolling, flattening of plates, etc. were studied. Characterization of spheroidal UO_2 particles was also carried out, and suggested fabrication procedures are summarized. (D.L.C.)

11697 (BMI-X-328) EXPLOSIVE WELDING OF FLAT PLATES OF ZIRCALOY TO INCONEL "600." R. J. Carlson, C. C. Simons, and E. G. Smith, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 26, 1965. Contract [W-7405-eng-92]. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Preliminary experiments are described which were aimed at developing explosive welding parameters suitable for metallurgically bonding together 4-in.-square plates to form a composite from which 3.4-in.-OD by 3.3-in.-ID by 1 to 1½-in.-long tubular transition joints could be machined. Both nominally smooth mating surfaces and machined contour surfaces were investigated in the study. Although some welding was achieved in these experiments, it was not sufficiently extensive nor sufficiently reproducible to satisfy the requirements of the application. (D.L.C.)

11698 (EURAEC-1239) PRODUCTION OF UO_2 POWDERS OF HIGH BULK DENSITY BY MELTING AND GRINDING AND THEIR PROCESSING INTO FUEL ELEMENTS. Quarterly Report No. 5, July 1–September 30, 1964. W. Duerrschnabel, W. Hoppe, B. Liebmann, O. Neumann, P. Saalfeld, and L. Schikarski (Nuklear-Chemie und Metallurgie G.m.b.H., Wolfgang bei Hannau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 013-63-7 TEED. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In a test production, 217 kg of fused UO_2 were prepared with the available installation in nine working days. The scrap to be reprocessed chemically comprised 0.6 to 0.7%. Further fusion tests were carried out in order to find out the influence of the fusion atmosphere on the quality of the product and to obtain a greater fusion yield per charge. The nitrogen content of UO_2 in air under a pressure of 400 torr lay between 50 and 600 ppm. With UO_2 heated under H_2 and fused under argon, the O/U ratio was 2.01 to 2.02. Experiments show that it is possible, by melting together the spillage when using small pellets, to obtain the same yields as when melting pellets of large diameter. A determination of the water content of powders from molten UO_2 yielded values comprised between 5 and 130 ppm according to the granulometry of the tube. Experiments for improving the vibration behavior of UO_2 powder by "vibration grinding" were not very successful. (auth)

11699 (IPP-4/15) KURZBERICHT KERAMIK — METALL — VERBINDUNGEN. (Short Report on Ceramics — Metals — Compounds). B. Berberich (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Sept. 1964. 10p. Dep.(mn).

The alloys Ni–Ti–W, Mo–Ni–Ti–W, and Mo–Ni–Ti–W–Fe were investigated with respect to their suitability for hard soldering to ceramics. The vacuum tightness and annealability of these alloys hard soldered to aluminum oxide ceramics were tested. All three metal–ceramic forms were vacuum tight and could be annealed. Future studies were indicated. (J.S.R.)

11700 (ML-TDR-64-63) FINAL REPORT ON TANTALUM ALLOY PROCESSING DEVELOPMENT. J. B. Hallowell, D. J. Maykuth, and H. R. Ogden (Battelle Memorial Inst., Columbus, Ohio). Mar. 1964. Contract AF33(657)-8911. 89p. OTS.

Four tantalum alloys were prepared in 4-¼-inch-diameter ingots, processed to sheet, and evaluated for mechanical properties. The specific compositions studied were Ta–5W–2.5Mo, Ta–10W–2.5Mo, Ta–17W, and Ta–10W

1Zr. The first three alloys were successfully processed to 6-inch-wide strips by a sequence of extrusion, forging, and rolling. Smaller sizes of sheet were obtained from the fourth alloy. Evaluation of the alloy sheet included room- and elevated-temperature tensile, stress-rupture, and bend ductility tests, as well as microstructural studies. Generally, each of the alloys shows a good combination of hot strength and low temperature ductility. The highest hot strength, 17,600 psi ultimate at 3500°F, was achieved with the Ta–17W alloy. (auth)

11701 (NMI-2132) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the Month of September 1964. (Nuclear Metals. Div. of Textron Inc., West Concord, Mass.). Nov. 30, 1964. Contract AT(30-1)-2784. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Efforts directed toward establishing fabrication steps for W–25 Re tubing are reported. Extrusions were performed to obtain stock for drawing of ¼ in.-OD and for re-extrusion of 80-mil OD tubing. Use of a CaC_2 leachable core is emphasized in re-extrusion. Results of evaluations of W–25 Re tubes extruded at 1600 and 1200°C showed that the annealing behavior of tubing extruded at 1200°C is independent of the extrusion reduction ratio and is not affected by prior extrusion at 1600°C. Extrusion data are included. Work on the fundamentals of single-crystal deformation in zone-refined Be is also reported. (J.R.D.)

11702 (ORNL-tr-406) EXPERIENCES IN WELDING LARGE THICKNESSES OF STEEL. Miroslav Hauner. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 18-26(1964). 18p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

Tests are described which were made on the manual welding of plates and rings of CSN 13030 steel of thickness up to 200 mm. The welding of the pressure vessel is next considered, and the techniques used in ensuring the quality of the welded sections are described. (D.L.C.)

11703 (ORNL-tr-407) EXAMPLES OF THE APPLICATION OF ELECTROSLAG WELDING IN LARGE DIMENSIONAL CONSTRUCTION. Josef Becka. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 27-32(1964). 13p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

Some examples are given of the techniques used in electroslag welding of products in the Pilsen nuclear power plant. These products include the rings and pressure vessel of diameter 5000 mm and wall thickness 150-600 mm. The construction of a 6000-ton loading apparatus and of rolling mill stands using electroslag welding is also described. (D.L.C.)

11704 THE METALLIZING OF CERAMIC POWDERS. H. P. Williams (Max-Planck-Institut für Silikatforschung, Würzburg, Ger.). Ber. Deut. Keram. Ges., 41: 639-44 (Nov. 1964). (In German)

In the manufacture of cermets, especially for reactor fuel elements, it is advantageous to coat the ceramic powder with the metal concerned. This may be carried out by electroless plating, which is, however, restricted to certain metals; by physical or chemical vapor plating, and by spraying a metal suspension onto the ceramic powder. Alumina powder was Ni coated by (a) reduction of a Ni salt solution, and (b) thermal decomposition of $Ni(CO)_4$. Mixed coatings of Mo_2C and Mo were deposited on 100 μm and 10 μm alumina powders by decomposing $Mo(CO)_6$ at 400°C. The spraying of a metal suspension onto a ceramic powder was successfully applied using very fine Mo. (auth)

11705 PREPARATION OF LARGE CRYSTALS OF α PLUTONIUM. Bernard Spriet (S.E.C.P.E.R., Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Compt. Rend., 259: 3529-32(Nov. 16, 1964). (In France)

A method for the preparation of large crystals of α Pu by phase transition $\beta \rightarrow \alpha$ under hydrostatic pressure is described. A treatment at 450°C and 35 kb followed by slow cooling under pressure leads to the formation of grains whose size is close to a millimeter. (tr-auth)

11706 DIFFUSION MECHANISM FOR THE NICKEL-ACTIVATED SINTERING OF MOLYBDENUM. J. T. Smith (Avco Corp., Wilmington, Mass.). J. Appl. Phys., 36: 595-8(Feb. 1965).

The sintering kinetics of cold-pressed molybdenum powder and molybdenum powder with nickel additions of 0.50–0.75 wt % were investigated in the temperature range from 1100 to 1400°C. Diffusion coefficients calculated from the sintering kinetics indicate that molybdenum densifies by a grain boundary diffusion process in the range 1100 to 1400°C. The activation energy for the process is about 38 kcal/mole. The nickel additions, present on particle surfaces, enhanced the sintering rate such that it was possible to achieve densities in excess of 90% of theoretical after sintering for only 60 min. It is suggested that the mechanism for the nickel-activated sintering of molybdenum is the increased diffusion rate of molybdenum through the grain boundary layer of nickel. An activation energy of 21 kcal/mole was determined for this process. (auth)

11707 EQUIPMENT FOR ELECTROSPRAYING. V. Verdingh and K. F. Lauer (EURATOM, Geel, Belg.). Nucl. Instr. Methods, 31: 355-6(Dec. 11, 1964).

A capillary allowing continuous spraying over a long period and at a constant flow rate was improved by using Pt wires and needles and sealing the Pt capillary directly into the glass tube of the container. An apparatus was constructed combining four capillaries to increase electrospraying efficiency. (M.J.T.)

11708 GRAPHITE SUPPORTING FILMS FOR THIN SOURCE AND TARGET PREPARATION. V. E. Viola, Jr. (CERN, Geneva) and D. J. O'Connell. Nucl. Instr. Methods, 32: 125-7(Jan. 1965).

A method for thin film preparation from colloidal graphite dispersed in isopropyl alcohol is presented. Free films with thicknesses of 10 $\mu g/cm^2$ can be prepared with areas as large as 30 cm^2. Thickness measurements are easily accomplished by spectrophotometric methods. The properties of these films as backing sources for nuclear decay studies and as targets for nuclear reaction measurements, particularly fission, are discussed. (auth)

11709 IMPROVEMENTS OF ELECTROSPRAYING TECHNIQUE. G. Bertolini, G. De Pasquali, and R. Fantechi (Euratom, (C.C.R., Ispra, Italy). Nucl. Instr. Methods, 32: 355-6(Feb. 1965).

A modification of an electrospraying technique for obtaining thin uniform deposits of radioisotopes for beta spectrometry or alpha-gamma angular correlation measurements is described. A hypodermic needle and a coneshaped electrostatic collimator were used. The device was used to concentrate radioactive deposits within a controlled, circular area. The size of the sprayed area depends on the flow rate and the applied field at the needle and at the collimator. A tungsten wire was used to regulate the flow of the liquid. (C.E.S.)

11710 FEATURES OF THE TECHNOLOGY OF MANUFACTURING COMPACT PARTS AND THE MECHANICAL PROPERTIES OF SOME HEXABORIDES OF RARE-EARTH METALS. B. G. Arabei, E. N. Shtrom, and Y. A. Lapitskii. Poroshkovaya Met., Acad. Nauk Ukr. SSR, No. 5, 65-70(Sept.-Oct. 1964). (In Russian)

Hot pressing characteristics and mechanical properties of hexaborides of lanthanum, samarium, europium, and dysprosium were studied. It is shown that compact parts, with a density close to theoretical, made of LaB_6, SuB_6, EuB_6, and DyB_6 may be obtained by hot pressing at a temperature of 1950 to 2050°C under a pressure of 500 dyn/cm^2. The hexaborides of rare earth elements have a high brittleness. Their bending strength at room temperature is 13 to 18 dyn/mm^2. (auth)

11711 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 7: 257-67(Winter 1964–1965).

Research on melting, casting, working, cladding, explosive forming, welding, brazing, and nondestructive testing is reviewed. (63 references). (M.C.G.)

11712 BERYLLIUM STRUCTURES. Ronald N. Kelly (Avco Corp., Wilmington, Del.). Space/Aeron., 42: No. 1, 64-73(July 1964).

Developments in beryllium technology for use in aerospace structures are discussed. Economics are also considered. It was concluded that Be has reached the point where, with intelligent design procedures, and with continued advances in fabrication techniques, it can be used to build structures that result in more defense for the dollar. (P.C.H.)

11713 IMPROVEMENTS IN OR RELATING TO RADIATION SCREENS. Raymond Marchal, Roger Chevalier, and Michel Combecave (to Commissariat a l'Energie Atomique). British Patent 973,050. Oct. 21, 1964. Priority date Sept. 1, 1961, France.

A process for the manufacture of lead screens such as are used for limiting the propagation of gamma radiation in the vicinity of the core of a nuclear reactor is described. The lead screen is encased in a light metal or alloy, such as aluminum or an aluminum alloy, to prevent corrosion. The screens are cooled by passing demineralized water through tubes located in the screen or through channels formed by corrugations welded to the screen. Essentially the lead screen is manufactured by providing on the inner face of the casing a metallic covering that includes one or more layers, cleaning the inner face of the covering so obtained by fluxing it, positioning the casing and any other non-lead parts of the screen in a mold, casting the lead both inside and outside the casing, and then removing the excess lead. (A.G.W.)

11714 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF SINTERED URANIUM DIOXIDE BODIES. James Edgar Littlechild (to United Kingdom Atomic Energy Authority). British Patent 972,534. Oct. 14, 1964. Filed May 9, 1961.

A method is described for producing sintered UO_2 bodies from shaped UO_2 bodies containing a bonding agent. The shaped UO_2 body is debonded by heating in a fluidized bed using a fluidizing gas inert to UO_2, e.g., CO_2, at a temperature (800°C) sufficient to volatilize the bonding agent. Two methods for subsequent sintering of the debonded bodies are described: (1) sintering in a second fluidized bed at 1650°C with H_2 as a fluidizing gas or (2) batch operation with sintering and debonding carried out in the same fluidized bed. This process is applicable on a large scale without cracking or chipping the sintered UO_2 bodies. UO_2 bodies that contain fluoride can be sintered by this method if the design materials for the construction of the fluidized bed system are chosen to avoid damage by HF. (A.G.W.)

11715 A PROCESS FOR PRODUCING A SINTERED METALLIC ARTICLE. (to Commissariat a l'Energie Atomique). British Patent 972,686. Oct. 14, 1964. Priority date Apr. 8, 1960, France.

A method is described for the production of sintered Ni articles by the extrusion of a mixture of metallic-nickel powder, graphite powder, and a gel-type binder followed by sintering at 1150-1200°C in a dry hydrogen atmosphere. The graphite is substantially eliminated by thermal treatment at 1100°C in a decarbonizing atmosphere consisting of moist hydrogen or of carbon dioxide. The degree of porosity and the size of the pores depend upon the proportion of graphite to nickel and grain size of the graphite. (A.G.W.)

11716 HIGH STRENGTH BERYLLIA ARTICLES. Percy P. Turner, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,165,417. Jan. 12, 1965.

The method of making a beryllia article having a restricted grain growth above 2500°F which consists of intimately mixing from 0.1 to 0.2 wt % of an inhibitor selected from the group consisting of C and refractory carbides with highly purified beryllia, pressing at about 10,000 psi to about 50,000 psi and sintering at temperatures of from about 2800°F to about 3300°F in a H_2 atmosphere. (AEC)

11717 CERAMIC COATED FUEL PARTICLES. L. D. Stoughton, J. M. Blocher, and N. D. Veigel (to U. S. Atomic Energy Commission). U. S. Patent 3,165,422. Jan. 12,1965.

A method of coating fissionable fuel particles such as UO_2 with a first layer of porous Al_2O_3 and an outer layer of impervious Al_2O_3 is described. The inner layer acts as a sump to trap and hold fission gases while the outer layer prevents the escape of the fission products. The Al_2O_3 coatings are applied in a reactor containing UO_2 powder. A fluidizing gas $AlCl_3$ is applied to the particles and H_2 partially saturated with water is separately supplied. The reaction in the fluidized bed reactor is conducted at below 900°C to obtain the porous layer and then at above 900°C to obtain the impervious layer of Al_2O_3. (AEC)

Properties and Structure

Refer also to abstracts 12476 and 12477.

11718 (AD-604052) THE PROPERTIES OF WELDED 18Ni-7Co-5Mo PLATE. Z. P. Saperstein and B. V. Whiteson (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Apr. 30, 1964. 60p. (SM-45959) $3.00(OTS).

An investigation was conducted to determine the fabricability of the 18Ni-7Co-5Mo alloy. Studies related to welding techniques, aging response, fracture toughness, metallurgical considerations, and delayed failure susceptibility are presented. Findings indicate that: "High Energy" inert-gas shielded metal-arc welding (MIG) techniques are completely adequate for the welding of ¾-inch thick 18Ni-7Co-5Mo plate. Welds containing 1.0% titanium show less sensitivity to wide variations in aging cycle, with respect to standard mechanical properties, than do welds made with the nominal titanium content of the parent plate (0.5%). The fracture toughness of welds is relatively insensitive to variations of welding technique, as well as weldmetal composition, when aged at 900°F for 12 hours. The welds have poorer fracture toughness characteristics than the parent plate, and the fracture path appears to be associated with an unidentified phase found in the weld-metal. Welds and parent metal of the 18Ni-7Co-5Mo alloy are exceptionally resistant to delayed failure susceptibility when compared to AISI 4340 steel, at equivalent strength levels. (auth)

11719 (AD-609315) THE MÖSSBAUER EFFECT OF Fe^{57} ON THE SURFACE OF TUNGSTEN. Technical Note No. 2. John Williams Burton (Illinois. Univ., Urbana). 1965. Contract AF49(638)-1048. $3.00(OTS).

The Mössbauer effect of ^{57}Fe on the surface of polycrystalline tungsten was measured over a temperature range of 80-500°K, and at angles of 0 and 60° with respect to the normal. The Mössbauer spectra consist of three unresolved lines, the middle one agreeing with measured spectra of ^{57}Fe in the bulk of tungsten, and the outer two being attributed to surface effects. The asymmetry of the surface spectra, the angular dependence of the shape, and the magnitude of the splitting of the two surface lines indicate an electric field gradient at the surface of 2.4×10^{16} v/cm² directed along the normal. An effective Debye temperature of 406 ± 12°K is found for the bulk, from a study of the temperature dependence of the intensity of the Mössbauer absorption. The effective Debye temperature for the surface is 354 ± 30°K along the normal, and 255 ± 30°K parallel to the surface. The angular dependence of the total intensity of the two surface lines agrees with a simple theory for an atom bound above the top layer of the host lattice. The isomer shift with respect to iron at 300°K is 0.0151 ± 0.0002 cm/sec in the bulk, and 0.018 ± 0.002 cm/sec on the surface. The temperature dependence of the shift was not determined with sufficient accuracy to detect any surface effects on the second order Doppler shift. Experimental apparatus and computer programs are described. (auth)

11720 (ARL-64-205) AN ANNOTATED BIBLIOGRAPHY OF RESEARCH ON THE STRUCTURAL AND PHYSICAL PROPERTIES OF ZIRCONIA. Berthold C. Weber (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Nov. 1964. 93p. OTS.

This bibliography covers the literature of the past 35 years although some older references are included. Three hundred and seven references have been individually evaluated. The discussion of the subject is arranged in twelve sections dealing with zircon minerals, synthetic zirconia, crystallographic polymorphy, impurity effects on structure, x-ray diffraction data, phase transformation, reactions, physical properties, etc. It is emphasized that the main reasons for conflicting literature data are due to inadequately defined test materials and insufficient control of experimental conditions. (D.L.C.)

11721 (CONF-543-20) DISLOCATION INTERACTIONS DURING THE PLASTIC DEFORMATION OF IONIC CRYSTALS AT LOW TEMPERATURES. B. S. H. Royce and R. Smoluchowski (Princeton Univ., N. J.). [1964]. Contract AT(30-1)-937. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The nature of the defects produced in alkali halides by dislocation interaction during plastic deformation may be in part understood by a study of the optical absorption of the sample. Certain point defects and more complex centers have known absorption bands and changes in these as a result of plastic deformation provide insight into the microscopic processes involved. Experiments are discussed in which the color centers produced by x-irradiation of deformed samples are used to detect the results of dislocation interactions. These measurements and the deformations are conducted at several temperatures between liquid hydrogen temperature and zero degree centigrade. The structure sensitivity of the observed effects is used as an indicator of the role of the dislocations in various temperature ranges. (auth)

11722 (EURAEC-1099) THE MECHANISM OF DIFFUSION AND PRECIPITATION OF HYDROGEN IN ZIRCONIUM AND ITS ALLOYS. Period Covered: May 1–August 31, 1964. (Bologna. Universita. Istituto di Fisica "A. Righi"). Work Performed under United States–Euratom Joint Research and Development Program. Contract 026-64-3-TEE I(RD). 63p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Electron microscopic observations on Zr gettering in air, N_2, and O_2 are reported. Research results on work hardening and recovery in Zr are also reported along with those obtained in research on hydride precipitation in annealed Zr and on mechanical properties of hydrogenated and non-hydrogenated Zr. (J.R.D.)

11723 (EURAEC-1207) STUDY OF THE EMBRITTLEMENT BY PLASTIC FATIGUE OF STEEL USED FOR REACTOR VESSELS. Quarterly Report No. 3, July 1–September 30, 1964. (Belgium. Centre National de Recherches Metallurgiques, Liege). Work Performed under United States–Euratom Joint Research and Development Program. Contract 005-63-12 TEEB. 48p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The plastic fatigue tests by compression-tension with specified load have revealed a fairly large scattering of results, as well as a marked influence of the direction in which the first load was applied (tension or compression). The biaxial plastic fatigue tests by alternate bending seem to be characteristic of a fairly weak scattering of endurances and may be represented by a straight line in a diagram in which log deformation is plotted against log number of total break cycles. Side bend tests on test pieces damaged by alternate bending plastic fatigue have revealed an embrittlement phenomenon of significant nature. Within the limits of the test criterion, this embrittlement does not appear to be influenced by the presence of fatigue cracks. The testing machine for traction and compression with specified deformation is described. Tensile properties of the steel sorts on which research was made are presented. (N.W.R.)

11724 (EURAEC-1217) THE DEVELOPMENT OF A NEW DETERMINATION OF THE DUCTILE-BRITTLE TRANSITION TEMPERATURE. Quarterly Report No. M 64-890-26150. H. C. van Elst (Netherlands. Nijverheidsorganisatie, TNO, The Hague). Oct. 30, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 068-61-11-RDN. 41p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The dependence of the isothermal arrest temperature on the thickness of Robertson-test specimens was further investigated. Also with a reactor-vessel steel the arrest temperature could be described as an exponential function of the thickness. A Moire technique was applied to study the deformation of fractured plates. The influence of cold work and artificial aging of steel on the temperature dependent behavior of specimens in the stress wave attenuation test was further investigated. The isothermal Robertson arrest temperature and Charpy-V impact temperature curves at these treatments of the steel were determined. At the stress wave attenuation test the lowering of the energy absorption by the embrittling treatment was more pronounced than the shift in transition temperature. This was due to the scatter in results, probably resulting from mutual specimen differences by inhomogeneities in the steel introduced at the aging process. The correlation of the three mentioned tests is discussed. There is an absence of transition characteristics in the stress wave attenuation test on aluminum at several temperatures. (N.W.R.)

11725 (EURAEC-1245) RARE GAS DIFFUSION IN SOLIDS. Quarterly Report No. 17, July–September 1964. (Hahn-Meitner-Institut für Kernforschung, Berlin). Oct. 1964. Work Performed under United States–Euratom Joint Research and Development Program. 14p. (EU-B35). Dep.(mn); $1.00(cy), 1(mn) OTS.

Investigations were carried out on the kinetics of the rare gas release from UO_2 and UC monocrystals during total evaporation in an attempt to determine the influence of evaporation on diffusion measurements. The results for the argon diffusion in KF, KCl, and KBr monocrystals were summarized as follows: KF: $D = 7.7 \times 10^{1} \exp(-40400/RT)$ for 400 – 800°C; KCl: $D = 2.3 \times 10^{-2} \exp(-14100/RT)$ for 400–700°C; $D = 5.5 \times 10^{11} \exp(55300/RT)$ for 200–400°C; KBr: $D = 1.8 \times 10^{-3} \exp(-8200/RT)$ for 500–700°C; $D = 1.5 \times 10^{5} \exp(-35700/RT)$ for 330–500°C. (auth)

11726 (MSAR-65-05) EFFECT OF HIGH TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 52, December 1964. (MSA Research Corp., Callery, Penna). Jan. 15, 1965. Contract AT(11-1)-765. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Some data are presented for Test 3 (Type 316 stainless steel in 1200°F high-carbon sodium) and Test 5 (Type 316 stainless steel in 1200°F high-oxygen sodium). The data include creep-rupture tests, fatigue tests, and impact tests. The status of the other tests is also reported. Metallurgical examinations are also described. Special fatigue runs were made on Type 304 stainless steel sheet in 1200°F air and high-oxygen sodium at 1.0 and 2.5% strain. (D.L.C.)

11727 (NYO-2471-4) A LOW TEMPERATURE INTERNAL FRICTION STUDY OF ALUMINUM AND MAGNESIUM AT 1 CPS (thesis). Report No. 281. Jules Lazar Routbort, II, (Cornell Univ., Ithaca, N. Y. Materials Science Center). Feb. 1965. 154p. Dep.(mn); $5.00(cy), 3(mn) OTS.

In aluminum, the lower Bordoni peak has an activation energy of 0.16 ± 0.01 ev with an attempt frequency of $5 \times 10^{12 \pm 0.6}$ sec^{-1}. This peak may have a single attempt frequency, but a distribution of activation energies. The upper Bordoni peak has an activation energy of 0.26 ± 0.03 ev with an attempt frequency of $3 \times 10^{14 \pm 1.3}$ sec^{-1}. The process contributing to this peak probably involves a distribution of attempt frequencies and a single activation energy. The relaxation strengths of the two processes probably is temperature dependent, a function of the mode of deformation, and of the temperature of deformation. Low-temperature gamma irradiation has no effect on these peaks. Cold work up to approximately 2 to 4% increases the peak heights. Further cold work results in no change of peak heights. Additional peaks, which anneal more rapidly than the Bordoni peaks at less than 300°K, are

observed in Al when the specimen is deformed at low temperatures or cooled quickly after deformation at room temperature. The appearance of these peaks is dependent only on the rate of quenching and the temperature of deformation. Low temperature gamma-ray irradiation did not induce these peaks. There is considerable annealing of these peaks and subsequent increase of the Bordoni peaks at low temperatures. These peaks are attributed to point defect interactions with dislocations, but assignment of a specific defect to a particular peak is not made. The recovery of Al follows a logarithmic time law. These results combined with the behavior of the background internal friction of Al and Mg after gamma ray irradiation indicate that another loss mechanism, not the Granato-Lücke mechanism, is dominant at these frequencies. A broad internal friction peak is observed in Mg. The peak height depends on the temperature of deformation. This peak is decreased by low-temperature gamma-ray irradiation, presumed to be due to vacancy pinning. The effect of gamma-ray irradiation indicates that there is either a difference in the defect pinning strengths between Mg and Al or that there is a difference in the production of defects by the gamma rays. Finally, the presence of $MgNi_2$ precipitates in Mg doped with Ni hinders the annihilation of dislocations and hence the friction is higher than for a pure crystal. (auth)

11728 (TID-21599) YIELD BEHAVIOR OF NIOBIUM SINGLE CRYSTALS. D. C. Huffaker (Illinois. Univ., Urbana). Sept. 1964. Contract AT(11-1)-1046. 67p. (TAM-268). Dep.(mn); $3.00(OTS).

The yield behavior of niobium single crystals was studied under conditions of different temperatures, strain rates, and microstructure. The effect of temperature and strain rate on the yield strength of the single crystal material investigated with ⟨110⟩ direction parallel to the compression axis seems to be characterized by the modified form of the rate process equation $\dot{\gamma} = Ae^{-[\Delta H^* - V(\tau - \tau_i)/RT]}$, where $\dot{\gamma}$ = strain rate (resolved on the (110) plane and in the ⟨111⟩ direction), A = frequency factor, ΔH^* = activation energy at zero effective stress, V = activation volume, τ = observed stress (resolved on the (110) plane and in the ⟨111⟩ direction), τ_i = internal (frictional) stress, R = universal gas constant, and T = temperature, °K. Within the range of variables studied, the frequency factor was found to be independent of stress, temperature, and microstructure and has a value of around 10^{7}/sec for the material investigated. The activation volume has been found to be dependent upon stress but independent of microstructure. The internal (frictional) stress was shown to vary with the dislocation density as determined by etch pitting and optical microscopy. Furthermore, the frictional stress was found to vary in an amount approximately proportional to the square root of the dislocation density. (auth)

11729 (YALE-2560-5) ATOMIC DISTRIBUTION IN MOLTEN SILVER–TIN ALLOYS. M. L. Joshi and C. N. J. Wagner (Yale Univ., New Haven). Dec. 1964. Contract AT(30-1)-2560. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Molten silver–tin alloys were studied by x-ray diffraction technique, using a focusing θ-θ diffractometer with Mo–Kα radiation (quartz crystal monochromator in the diffracted beam). The scattered intensities I_{eu}^{coh} in electron units and the interference function $I(K) = I_{eu}^{coh}/f^2$ (f being the scattering factor) were measured in the range of $K = 4\pi \sin\theta/\lambda = 1.4$ A^{-1} to K = 15 A^{-1} for 6 different alloy compositions at temperatures 100°C above the liquidus line. Four alloys (from 62 to 82% Ag) were measured at 825°C. The positions of the first maximum of I_{eu} or I(K) shift considerably with increasing silver content from K = 2.25 A^{-1} for pure Sn to K = 2.64 A^{-1} for pure Ag. The radial distribution function $4\pi r^2\rho(r)$ and the probability function $W(r) = \rho(r)/\rho_0$, where $\rho(r)$ and ρ_0 are the atomic and average atomic densities respectively, were obtained by Fourier transform of I(K). The positions of the first maximum of $4\pi r^2\rho(r)$, (i.e., r_1) and of W(r), (i.e., r_1') are a measure of the interatomic distances, and vary from r_1' = 3.18 A for Sn to r_1' = 2.86 A for Ag. The plot of r_1 vs composition of the alloys shows a negative deviation from a linear law. A discontinuity appears in the curve in the range of 50 to 60% Ag. The coordination number Z increases rapidly on addition of Ag to Sn (Z = 8.5 for Sn) and reaches a value of about 11 beyond 60% Ag. (auth)

11730 (ORNL-tr-410) BRITTLE FRACTURES IN MATERIALS AND RESISTANCE TO BRITTLE FRACTURE. Karol Kalna and Stanislav Havel. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 71-84(1964). 41p. Dep.(mn); $4.60(fs), $1.43(mf) JCL.

A discussion is presented of the formation and propagation of brittle fractures under static load at normal temperatures. The effects of notches, sample size, energy, residual stresses, metallurgical factors, and radiation damage are considered. Tests for brittle strength and testing equipment are described. (D.L.C.)

11731 BINARY INTERMETALLIC COMPOUNDS OF RARE-EARTH ELEMENTS WITH OTHER METALS. CONTRIBUTION TO THE STUDY OF METALLIC COMPOUNDS OF THE SYSTEM La–Tl. P. Spacu and G. D. Cismaru. Acad. Rep. Populare Romine, Studii Cercetari Chim., 11: 399-410(1963). (In Romanian)

Studies were made on the synthesis and specific electric conductivity of the metallic compounds La_2Tl, LaTl, and $LaTl_3$, and the criterium for variation of specific electric conductivity was established. It was shown that, for the metallic compounds studied, the specific electric conductivity follows an exponential law represented by $\sigma = A\, e^{Kc_{Tl}}$ where c_{Tl} represents the atomic concentration of the hyperelectronic element Tl, expressed in atomic fractions. The studies were made at 0 and 25°C. The values of the constants A and K are A = 22.82 Ω^{-1} cm^{-1} and K = 10.87 at 0°C and A = 23.46 Ω^{-1} cm^{-1} and K = 10.73 at 25°C. (tr-auth)

11732 PHASE RELATIONS IN THE COMPOSITION RANGE $UO_{2.60}$ TO UO_3. Toshiyuki Sata (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Tech., Ser. B, No. 56, 21-44 (Oct. 1963).

Phase relations in the composition range $UO_{2.60}$ and UO_3 were investigated in oxygen, air, and nitrogen atmospheres by the quenching method followed by O/U atom ratio and x-ray diffraction measurements. Starting materials were UO_2, $UO_{2.63}$, $UO_{2.756}$, and UO_3 (chiefly UO_3). From several isobaric curves and distributions of lattice parameters obtained, the situation of U_3O_{13+x} or U_3O_{8+x} composition was too complex to determine the phase boundary in this step. The boundary was found at an O/U ratio of about 2.65 where there was a little change in the orthorhombic structure. However, this boundary did not agree with the break or horizontal region on the isobaric curve, where a hexagonal form similar to the high-temperature modification of orthorhombic U_3O_{13+x} or U_3O_{8+x} coexisted in a high-temperature state. $UO_{2.60}$ (U_3O_{13}) may dissolve the nonstoichiometric excess oxygen. The three distinct compounds corresponding to the compositions $U_{13}O_{35}$, $U_{15}O_{40}$ (U_3O_8), and $U_{17}O_{45}$ on each isobar in oxygen, air, and nitrogen respectively were seen as vertical lines of the isobars. UO_3 coexists with U_3O_{8+x} at an O/U ratio of about 2.7, and it is shown as the horizontal line on the isobar. (auth)

11733 HIGHLY REFRACTORY CERAMIC MATERIALS USED IN ELECTROTHERMICS. Zdenek Ryska. Elektrotech. Obzor, 53: 265-7(1964).

A continuation of a previous study (Elektrotechnicky Obzor, no. 5 (1963) page 247) pertaining to highly refractory ceramic materials which are used in electrothermics and which have been recently finding an ever-increasing application in rocket and atomic engineering is presented. These materials are used in equipment operating at high vacuums such as that in oil diffusion pumps, i.e. 1×10^{-9} mm Hg, 10^{-12} mm Hg in mass spectrometers, and 10^{-14} mm Hg in measuring equipment with photomultipliers. The new areas of application of these materials permit a wider use of electric heat sources with a high temperature gradient (e.g. electric arc, plasma, electronic heating). The characteristics of the most important metal oxides (Al_2O_3,

MgO, SiO_2, ThO_2, ZrO_2, BeO) are given with respect to vapor tension, especially at high vacuum. These oxides are of especial importance in the production of high-quality materials and their heat treatment such as bright annealing without protective atmosphere is discussed. (auth)

11734 ALLOYING EFFECT ON NIOBIUM PHYSICAL AND MECHANICAL PROPERTIES. N. D. Tarasova, R. A. Ul'yanov, and Ya. D. Mikhailov (Inst. of Physics and Tech., Khar'kov). Fiz. Metal. i Metalloved., 18: 740-5(Nov. 1964). (In Russian)

Experimental studies of alloying effects on the modulus of elasticity and yield strength of niobium at 1300 and 100°C showed that Ir, Mo, Re, Ta, and W increased the modulus of elasticity and the strength of the metal. It was also found that in niobium alloyed with B, La, and Si, boron had the best strengthening effect on the metal. (R.V.J.)

11735 COMPRESSIBILITY OF CERIUM UP TO 30,000 kg/cm^2. V. V. Evdokimova and Yu. S. Genshaft. Fiz. Tverd. Tela, 6: 2449-52(1964).

The compressibility of γ-Ce was studied by the "piston-displacement" method and by the x-ray diffraction method. Results indicate that the dependence of the volume decrement ($\Delta V/V_0$) on pressure for both α-Ce and γ-Ce was determined. The behavior of the γ-Ce (low-pressure phase) was found to be abnormal, i.e., its compressibility increased with increased pressure. The α-Ce (high-pressure phase) behavior under pressure was normal, i.e., the compressibility decreased with pressure increase. The polymorphic transformation $\alpha \rightleftharpoons \gamma$ under pressure was found to take place at approx. 7000 kg/cm^2, but residual γ-Ce was found at pressures as high as 14,000 kg/cm^2, and the α-Ce phase can be preserved under conditions of very slow pressure decrease for as long as one or two years. (auth)

11736 THE STRENGTH OF DISPERSION-STRENGTHENED COPPER ALLOYS CONTAINING A DISPERSED PHASE OF THORIA, ALUMINA OR TUNGSTEN. Yasuji Fujii (Furukawa Electric Co., Ltd., Japan). Funtai Oyobi Funmatsuyakin, 11: No. 1, 14-22(Feb. 1964). (In Japanese)

The influence of the kind of dispersed phase on the mechanical properties of dispersion strengthened copper alloys is discussed. The specimens were prepared by ball mill mixing of electrolytic copper powder (−325 mesh) with dispersed powder, followed by compacting, sintering, hot extruding and cold drawing, and annealed at 600°C for 1 hr in vacuum before testing. Thoria, alumina and tungsten powders were used for the dispersion particle. For comparison, two kinds of pure copper were prepared, one of the sintered electrolytic copper powder and the other of the ingot of vacuum-melted cathode copper. The experimental results showed that the strength of dispersion strengthened alloys could be determined by the interfacial energy between the copper matrix and the dispersed phase, the adhesion of the dispersed phase to the matrix, the degree of dispersion of particles in the matrix, and the thermal stability of the dispersed phase. Copper-thoria alloy was the best among the three dispersed strengthened alloys. The grain size of the metal matrix of the dispersion strengthened alloy was progressively smaller with an increase in the amount of dispersed phase. In the case of pure metal or solid solution alloy, it was shown in general that the smaller the grain size, the higher the strength. For the dispersion strengthened alloy, the strength was affected much more by the dispersion strengthening mechanism of dispersed particles themselves than by the grain size of the matrix. (auth)

11737 NEUTRON-ABSORBING GLASS-CERAMICS. P. W. McMillan and B. P. Hodgson (English Electric Co., Ltd., Stafford, Eng.). Glass Technol., 5: 142-9(Aug. 1964).

Glasses based on the systems $CdO-In_2O_3-SiO_2$ and $CdOIn_2O_3-B_2O_3$ were investigated for use in reactor control rod fabrication. These materials were found to be impermeable and have high neutron-absorption coefficients and high mechanical strengths. The materials appear to be compatible with canning materials and resistant to shock. It is concluded that such glasses are useful in control rod fabrication. (J.R.D.)

11738 MAXIMUM CREEP ACTIVATION ENERGY IN TITANIUM−ZIRCONIUM ALLOYS. K. A. Osipov and A. L. Sotnichenko. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 27-31(1963). (In Russian)

The creep rate of polycrystalline specimens of Ti−Zr alloys (25.1, 50, and 75.1 at. % Zr) in the α modification was tested in a vacuum (1×10^{-4} mm Hg) at 800°C for 24 hr and at applied pressures of 30, 35, 40, 45, 50, 55, 60, 65, and 70 kg/mm^2. Some creep curves were analyzed. A fast disintegration of alloys with 25 and 5 at. % Zr at over 70 kg/mm^2 pressure and 75.5 at. % Zr alloys at over 60 kg/mm^2 pressure prevented the investigation of their creep properties. (R.V.J.)

11739 STEADY STATE CREEP OF β MODIFICATION OF TITANIUM−ZIRCONIUM ALLOYS. K. A. Osipov, E. M. Miroshkina, and A. L. Sotnichenko. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 105-9 (1963). (In Russian)

The steady creep of Ti−Zr alloys in the α modification was studied with specimens containing 25, 50, 61, and 75.7 at. % Zr annealed in a 1×10^{-4} mm Hg vacuum at temperatures to 1000°C for 24 hr. The tabulated data showed that a minimum steady creep was observed with 50 at. % Zr specimens at 800, 900, and 950°C. Increases in the Zr content increased the rate of creep. Creep activation in Ti−Zr alloy in the β modification was also analyzed. (R.V.J.)

11740 PROPERTIES OF NIOBIUM−TUNGSTEN−TITANIUM ALLOYS. D. A. Prokoshkin, E. V. Vasil'eva, and N. N. Popov. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 219-25(1963). (In Russian)

The specific gravity, hardness, high-temperature creep, and oxidation properties were studied with test ingots prepared from Nb−W−Ti alloys containing 15 wt % W and 3, 10, 15, and 20 wt % Ti, annealed at 1700°C for 48 hr. The high-temperature hardness (at 600 to 1000°C) increased with increasing Ti content. The creep strength was only slightly affected by Ti content, the rate of oxidation tended to decrease with increasing Ti content, and the rate of oxidation tended to decrease with increasing Ti content, reaching a minimum at 10% Ti. (R.V.J.)

11741 PENETRATION OF AN ION THROUGH A MONOLAYER OF SIMILAR IONS ADSORBED ON A METAL. J. W. Gadzuk and E. N. Carabateas (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 357-60(Feb. 1965).

A fractional monolayer film of ions is formed by the adsorption of a gas onto a metal substrate. These ions form a discrete dipole layer, the potential across it being the change in electron work function of the surface. As additional ions are brought to the surface, they penetrate only a fraction f of the potential across the dipole layer. The penetration coefficient f valid for the entire range of coverages is derived for two limiting types of films, immobile and mobile. By considering thermal effects, a penetration coefficient for partially mobile films is also derived. The values obtained for the penetration coefficient are applicable to any substrate-adsorbate system. The theoretical expressions for the penetration coefficient are evaluated for cesium on tungsten and compared with the data of Taylor and Langmuir. (auth)

11742 IMPROVED THERMIONIC EMITTER: THORIUM ON GRAIN-ORIENTED POLYCRYSTALLINE TUNGSTEN. Ira Weissman (Varian Associates, Palo Alto, Calif.). J. Appl. Phys., 36: 406-11(Feb. 1965).

A grain-oriented polycrystalline thoriated tungsten emitter is described which demonstrates vastly improved emission characteristics over ordinary emitters of the same type. The factor of four improvement in electron emission in high vacuum is almost entirely the result of an increase in A value from four to seventeen. The Richardson work function ϕ of the improved emitter is essentially the same as that of the ordinary one. A comparison is made of the efficiencies of two cesium-neutralized thermionic converters, identical in every respect except that one contains the improved emitter and the other an ordinary one. The measured improved factor of

three in conversion efficiency is in close agreement with the predicted factor based on the difference in A values. (auth)

11743 THE SYSTEMS TERBIUM OXIDE-YTTRIUM OXIDE AND TERBIUM OXIDE-ERBIUM OXIDE. L. Wolf and H. Schwab (Karl-Marx-Universitat, Leipzig). J. Prakt. Chem., 24: 293-304(1964). (In German)

Samples of $TbO_{1.5}-YO_{1.5}$ and $TbO_{1.5}-ErO_{1.5}$, reduced at 1000°C in an H_2 stream for one hour, heated under N_2 at 1350°C for one hour, and then cooled to room temperature under N_2, had lattice constants proportional to their composition; Vegard's rule was strictly followed. Samples of $TbO_x-YO_{1.5}$ and $TbO_x-ErO_{1.5}$, heated to 1200°C in a quartz vessel, cooled to 650°C within 30 min and maintained at 650°C ± 5° for several hours, and then cooled to room temperature in vacuum, gave reproducible results. The following lists atomic % Tb, and lattice constants in kX for a $TbO_x-YO_{1.5}$ sample held 3 hours at 650°C: 0, 10.584; 40, 10.625; 42.5, 10.591; 50, 10.575; 60, 10.570; and 100, 10.600; for a $TbO_x-ErO_{1.5}$ sample held 4 hours at 650°C: 0, 10.527; 40, 10.583; 50, 10.552; 60, 10.552; and 100, 10.600. Up to 40% Tb the cubic structure holds; after 40% a transition to the fluorite structure occurs gradually. Two opposing effects may be distinguished: valence stabilization of Tb in mixed crystals with sesquioxides, and increases in oxidizability of Tb in the presence of sesquioxides. Disposable O was determined: x is given for TbO_x in samples of mixtures from mixed oxalates; x′ for total $MO_{x'}$; and finally atomic % Tb, for Y mixed oxide: 1.56, 1.51, 10; 1.65, 1.56, 40; 1.81, 1.66, 50; 1.82, 1.69, 60; 1.81, 1.72, 70; 1.78, 1.74, 80; and 1.72, 1.72, 100. For Er mixed oxide: 1.55, 1.51, 10; 1.71, 1.58, 40; 1.84, 1.67, 50; 1.83, 1.70, 60; 1.81, 1.72, 70; and 1.73, 1.73, 100. (BBB)

11744 COMPOUNDS WITH A SUPERLATTICE SUCH AS ALPHA MANGANESE IN SYSTEMS OF RARE EARTH METALS AND MAGNESIUM. P. I. Kripyakevich, V. I. Evdokimenko, and E. I. Gladyshevskii. Kristallografiya, 9: 410-11(1964).

Alloys of Tb, Ho, Tm, Yb, and Lu were prepared containing 82.8 at. % of Mg in the charge (i.e., corresponding to a composition of R_6Mg_{24}), by alloying Tb (99.15%, 0.5% other rare earths), Ho (97.4%, 2.1% other), Tm (94.7%, 5.1% other), Yb (99.96%, 0.005% other), and Lu (95.7%, 3.8% other) with Mg (99.9%) in crucibles of MgO with a flux (LiCl + KCl) in a furnace (atmosphere of He or Ar). The alloys are silvery white, and they oxidize in air, but much more slowly than alloys of Mg with rare earths of the Ce group. X-ray studies show that Tm and Lu alloys contain pure compounds of Ti_6Re_{24} type, but that Tb and Ho alloys contain this type of compound in equilibrium with other compounds, particularly $TbMg_3$ and $HoMg_2$. Experimental intensities for Tm_6Mg_{24} (visual observation) are in agreement with computed values. X-ray patterns for other compounds of the type R_6Mg_{24} are almost indistinguishable from those for Tm_6Mg_{24} relative to experimental intensities. The lattice constant a for various compounds with the formula R_6Mg_{24}, in Å, are: 11.283, 11.246, 11.233, 11.224, 11.208, 11.185, and 11.257 for Tb, Dy, Ho, Er, Tm, Lu, and Y, respectively. The value may be seen to decrease with increase in atomic number (except for Y, which is between Tb and Dy). (auth)

11745 CLASSIFICATION OF MAGNETIC STRUCTURES AND THE METHOD OF NEUTRON DIFFRACTION MEASUREMENTS. Emil Kren and Endre Praveczki (Central Physical Research Inst., Budapest). Magy. Fiz. Folyoirat, 12: 387-414(1964). (In Hungarian)

On the basis of magnetic structure determinations carried out during the past few decades, most of the materials were classified as a member of the collinear ferromagnetic, antiferromagnetic, or ferrimagnetic groups. However, recent theoretical studies indicated that noncollinear structures may also be stable. In addition, neutron diffraction and magnetic studies yielded results which cannot be explained on the basis of a collinear structure. These cases are reviewed on the basis of a magnetic classification scheme, disregarding symmetry considerations. The magnetic moment vectors obtained from neutron diffraction measurements are presented in the form of Fourier transforms. It was concluded that the magnetic structure cannot be determined unequivocally on the basis of neutron diffraction measurements. The deviations may be due to problems involving the form factor and the unavailability of single crystals for the measurements. (TTT)

11746 COMPARATIVE STUDY OF BODY-CENTERED CUBIC METALS IN GROUPS IV AND VIII. N. P. Allen (National Physical Lab., Teddington, Middx, Eng.). Mem. Sci. Rev. Met., 61: 827-40(Dec. 1964). (In French)

The concept of an isomorphous series of metals or transmutation series is discussed. The influence of electron structure on such physical properties as melting point, density, modulus of elasticity, superconductivity, and paramagnetic susceptibility was studied. Also investigated was the effect of electron structure on such mechanical and metallurgical properties as plastic behavior, brittle fracture, and ductile fracture. The influence of metal purity on transition temperature was also considered. (M.C.G.)

11747 LAYER DIAMETER IN GRAPHITE. W. T. Eeles and A. J. C. Wilson (Central Electricity Generating Board, Berkeley, Eng.). Nature, 205: 66(Jan. 2, 1965).

An examination was made on three samples of commercial graphite, for which the integral breadths of the $11\bar{2}2$ reflexions indicate that mistakes in the layer sequence occur about every 6 planes, and the use of the ordinary Scherrer formula for particle size indicates layer diameters of 200-500 A. Two of the samples showed no signs of heterogeneity, and gave apparent layer diameters of 3000-4000 A. The third graphite appeared to be composite, with the reflexions showing sharp and diffuse components simultaneously. The apparent layer diameter was 160 A, in agreement with previous x-ray measurements, and is presumably typical only of the component producing the diffuse lines. The intercepts of the variance-range curves indicated that some part of the breadth of the $11\bar{2}0$ reflexions was caused by strain in the layers. Several methods for estimating the layer diameter in graphite are discussed. (P.C.H.)

11748 SOME STUDIES ON THE CLADDING TECHNIQUES FOR METALLIC URANIUM FUEL. II. DIFFUSION BEHAVIOR OF ALUMINIUM IN METALLURGICAL BONDING. Takao Konishi. Nippon Genshiryoku Gakkaishi, 6: 700-6(Dec. 1964). (In Japanese)

Diffusion behavior of aluminum in metallurgical bonding was studied in connection with the development of the cladding techniques for metallic uranium fuel elements. Preliminary test results on the metallurgical bonding of Al-Ni-U alloy indicated that the growth of the Al-Ni diffusion layer was more rapid than that of Ni-U and that it would determine the lifetime of the fuel element. A detailed study was initiated on the formation of intermediate layers in the Al-Ni diffusion zone. It was confirmed that only two observable layers are formed during diffusion, $\gamma(Ni_2Al_3)$ and $\beta(NiAl_3)$. Three layers were observed in the case of an Al-Cu diffusion zone, while no detectable intermetallics appeared in the interface in the Al-Nb couple. The growth of the intermediate layers occurred initially at a linear rate. However, once a certain thickness was obtained, the behavior became more normal or parabolic. The activation energy of $Al_3Ni_2(\gamma)$ formation was estimated to be 37 kcal/mole and for Al-Cu diffusion, 23 kcal/mole. (auth)

11749 PARAMETERS OF α PLUTONIUM AT LOW TEMPERATURES. P. Solente (CEN, Fontenay-aux-Roses, France). Phys. Letters, 13: 283-5(Dec. 15, 1964). (In French)

The evolution of the parameters of the unit cell of α Pu was studied as a function of temperature from 18 to 300°K, using a diffractometer. The results are graphed and are in good agreement with previous studies made at 77 and 4°K, but disagree with results obtained with stress gages or neutron diffraction below 50°K. The consequences of the results obtained are discussed; the possibility of an antifer-

romagnetic transition at low temperature is considered. (J.S.R.)

11750 TEMPERATURE DEPENDENCE OF THE DEBYE-WALLER FACTOR OF PLATINUM. J. R. Harris, N. Benczer-Koller, and G. M. Rothberg (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 137: A1101-5 (Feb. 15, 1965).

The Mössbauer absorption spectrum of the 99-kev gamma ray of ^{195}Pt in platinum metal was studied from 20 to 100°K. In a separate experiment, the internal-conversion coefficient α was found to be $\alpha = 7.2 \pm 0.7$. Using this value of α the fraction of recoilless emission f_s and recoilless absorption f_a are $f_s(20°K) = 0.089 \pm 0.002$, $f_s(77°K) = 0.021 \pm 0.003$, and $f_a(20°K) = 0.129 \pm 0.008$, $f_a(77°K) = 0.043 \pm 0.011$. The half life of the 99-kev level is $\tau_{\frac{1}{2}} = (1.7 \pm 0.2)\ 10^{-10}$ sec in agreement with the electronic measurement $\tau_{\frac{1}{2}} \approx 1.4 \times 10^{-10}$ sec. The Debye temperature θ_{DW} determined from the Debye-Waller factor is in good agreement with a calculation based on the quasi-harmonic approximation. The Debye temperature extrapolates to $\theta_{DW} = (234 \pm 6)$°K at 0°K and is essentially independent of temperature up to 100°K. (auth)

11751 SEEBECK EFFECT IN HEAVY RARE-EARTH SINGLE CRYSTALS. L. R. Sill and Sam Legvold (Ames Lab., Ames, Iowa). Phys. Rev., 137: A1139-45(Feb. 15, 1965). (IS-975)

Seebeck coefficients S were measured along the three crystallographic directions $\langle 11\bar{2}0\rangle$, $\langle 10\bar{1}0\rangle$, and $\langle 0001\rangle$ for the heavy rare-earth metals Gd, Tb, Dy, Ho, and Er over the temperature range 7 to 300°K. The $\langle 10\bar{1}0\rangle$ and $\langle 0001\rangle$ directions of Y were also measured. In the cases of Gd and Tb, a 1000-Oe field along the $\langle 0001\rangle$ and $\langle 10\bar{1}0\rangle$ directions, respectively, caused no marked change. A significant anisotropy between the $\langle 0001\rangle$ direction and the basal plane was found for all the metals except Y. The magnetic order-disorder temperatures are marked by changes in slope in the S-versus-T curves. A discontinuity in S at the magnetic transition is evident in the case of Dy. (auth)

11752 THE INFLUENCE, STARTING FROM 1,500°C, OF THERMIONIC EMISSION ON THE MEASUREMENT OF THE RESISTIVITY OF OXIDES. J.-P. Loup and A.-M. Anthony (C.N.R.S., Bellevue, France). Rev. Hautes Temp. Refractaires, 1: 15-20(Jan.-Mar. 1964). (In French)

Experiments carried out in a furnace operating in air, at atmospheric pressure revealed that at temperatures starting from 1,500°C leak resistance appear between two insulated rods of alumina. These resistances vary exponentially in inverse ratio to the temperature and depend on the polarization of the furnace, in relation to these rods. Heating of zirconia by the Joule effect permits to study the nature of the charges emitted by refractories at high temperatures. Experimental study and calculation invalidate the hypothesis of thermal ionization by air. Thermionic emission explains the observed phenomena. It is important to take into account these leak resistances when measuring the resistivity of refractory oxides, which are poor conductors at temperatures above 1,500°C. (auth)

11753 A STUDY OF THE ZIRCONIA–SCANDIUM OXIDE SYSTEM: A COMPARISON WITH OTHER SYSTEMS OF THE TYPE $AO_2-M_2O_3$. Jean Lefèvre (C.N.R.S., Vitry-sur-Siene, France). Rev. Hautes Temp. Refractaires, 1: 229-37(July-Sept. 1964). (In French)

The systems $AO_2-M_2O_3$ formed by the oxides of heavy tetravalent elements and rare-earth oxides are characterized at high temperatures by the eixstence of two very extensive phases: the two primary solid solutions, either linked or not linked by a continuous transition. Ordered structures appear at lower temperatures. The system $ZrO_2-Sc_2O_3$ is quite different: three new intermediate phases β, γ, δ, have been found and their structures determined. This system shows a great similarity to systems of the type $AO_2-A_2O_3$ (A = Ce, Tb, Pr). (auth)

11754 X-RAY STRUCTURAL STUDY OF PRASEODYMIUM AND SAMARIUM ALUMINATES. N. V. Margolis, N. A. Toropov, and Yu. P. Udalov (Leningrad Technological Inst.). Soviet. Phys.-Cryst. (English Transl.), 9: 328-9 (Nov.-Dec. 1964). Translated from Kristallografiya, 9: 408-10(May-June 1964).

Results obtained in studies of Pr and Sm aluminates in monocrystalline and powdered form are presented. Conclusions concerning crystal structure of these compounds based on x-ray photography are given. (J.R.D.)

11755 DIFFUSION OF CERTAIN RARE EARTH ELEMENTS INTO GERMANIUM. I. A. Gusev, L. I. Molkanov, and A. N. Murin. Soviet Phys.-Solid State (English Transl.), 6: 980-1(Oct. 1964). Translated from Fiz. Tverd. Tela, 6: 1256-7(Apr. 1964).

Diffusion of some lanthanides into Ge was measured by vacuum evaporation onto the Ge, heating, sectioning, and comparing the activity of the layers with that of standards of the same impurity. The ratioisotopes ^{141}Ce, ^{147}Nd, ^{153}Sm, ^{160}Tb, ^{175}Yb, and ^{176}Lu were used; temperature and time of heating and the measured diffusion coefficients are presented. (M.J.T.)

11756 STUDY OF THE SURFACE MIGRATION OF MOLYBDENUM BY FIELD-EMISSION METHODS. I. L. Sokol'skaya, Kh. Noimann, and É. Kloze (Leningrad State Univ.). Soviet Phys.-Solid State (English Transl.), 6: 1126-33(Nov. 1964). Translated from Fiz. Tverd. Tela, 6: 1439-48(May 1964).

The activation energy of the surface migration of molybdenum atoms over their natural lattice is determined from the temperature dependence of the transient behavior of the field-emission current during heating of a single-crystal molybdenum needle in a strong electrostatic field. The value obtained is $Q_F = 2.00 \pm 0.05$ ev. The migration energy without the field is $Q_0 = 2.86 \pm 0.15$ ev. It is shown that the difference between these values may not be ascribed to a reduction of the binding energy of surface atoms in a strong field. The surface tension coefficient and the relation between the activation energy and the binding energy of the nearest neighbors in the molybdenum lattice are estimated. (auth)

11757 ON THE DEPENDENCE OF σ_{zz} OF GRAPHITE ON TEMPERATURE. Yu. A. Pospelov (Inst. of High Pressure Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 6: 1193-4(Nov. 1964). Translated from Fiz. Tverd. Tela, 6: 1525-7(May 1964).

The electrical conductivity of graphite along the trigonal axis σ_{zz} first decreases with increasing temperature and then increases after passing through a minimum on the σ_{zz} (T) curve at about 200°K. An analysis is made of this anomalous behavior of σ_{zz}(T). In the τ-approximation, based on the Sloczewski-Weiss model of the electron spectrum of graphite, an expression for σ_{zz} is derived. A nonmonotonic function σ_{zz} (T) with a minimum at about 200°K follows from this expression. In the first approximation the coordinate of the minimum T_{min} is determined only by the charge carrier distribution and is independent of the details of the scattering mechanism. It is proportional to the parameter γ_2 in the electron spectrum model of graphite, and for a specimen subjected to a pressure it should shift in the direction of higher temperatures (because of the increase of γ_2). (auth)

11758 THE SYSTEM U–C–N. Masahiro Katsura and Shosuke Imoto (Osaka Univ.). Technol. Rept. Osaka Univ., 14: 643-52(Mar. 1964).

The equilibrium phase diagram for the system U–C–N was constructed qualitatively from thermodynamic calculations. From the known values of the free energy of formation of several uranium compounds in the system U–C–N, the condition of stable existence of the solid solution between UC and UN, $UC_{1-x}N_x$, was determined. Several ternary sections were obtained at constant temperature and constant pressure of nitrogen gas. In order to examine these results, some experiments were carried out under several different conditions of temperature and pressure of nitrogen gas. A good agreement was found between the thermodynamic calculations and the experimental results. (auth)

11759 STUDIES ON URANIUM DICARBIDE AND SESQUICARBIDE. Tadao Sano and Shosuke Imoto (Osaka Univ.). Technol. Rept. Osaka Univ., 14: 653-62(Mar. 1964).

Some information on the composition of uranium dicarbide and the formation of uranium sesquicarbide was obtained by physical and chemical inspections of sintered uranium carbides. The composition of cubic dicarbide above 1800°C was $UC_{1.86\pm0.02}$ and that of tetragonal dicarbide below 1800°C, $UC_{1.96\pm0.04}$. The critical temperature of the decomposition of tetragonal dicarbide into the sesquicarbide and free graphite lay between 1500 and 1600°C. The synthetic reaction for the formation of the sesquicarbide occurred earlier than the decomposition reaction below the critical temperature. A new U-C phase diagram around uranium dicarbide was obtained. (auth)

11760 ANISOTROPY OF THE MAGNETIC PROPERTIES OF GADOLINIUM NEAR THE CURIE POINT. K. P. Belov, Yu. V. Ergin, R. Z. Levitin, and A. V. Pedko (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 2080-4 (Dec. 1964). (In Russian)

The temperature dependence of the magnetic anisotropy energy is calculated on basis of the magnetization curves of gadolinium single crystals measured near the Curie point along the a and c axes. It is shown that the anomalous increase of the anisotropy constant upon approach to the Curie point and its strong dependence on the magnetic field can be explained by the effect of the paraprocess. A noticeable anisotropy of the Curie point is observed in gadolinium single crystals. (auth)

11761 THE MÖSSBAUER EFFECT IN IMPURITY Sn^{119} NUCLEI IN BINARY METALLIC SOLID SOLUTIONS. V. A. Brukhanov, N. N. Delyagin, and V. S. Shpinel (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 2085-90 (Dec. 1964). (In Russian)

Mössbauer effect probabilities and isomeric energy shifts of the γ transition for ^{119}Sn nuclei incorporated into the Ag–Pd, Ag–Au, Ag–In binary matrices and also in Ag–Sn alloys as an impurity are measured. The dependences of electron density on the impurity nucleus and the effective Debye temperatures characterizing the probability of the effect on the composition of the binary matrices are obtained in a broad range of concentrations. It is shown that the probability of the effect as well as the magnitude of the isomer shift (and also the width of the absorption lines) are very sensitive to the nature of the electron structure of the matrices. In particular, it is found that the dependences for a matrix containing a transition metal (Pd) sharply differ from those found for other matrices. Behavior features of various types of impurity atoms in metallic matrices are discussed. (auth)

11762 Mn_5Si_3 TYPE COMPOUNDS IN RARE EARTH ALLOYS WITH GERMANIUM. E. I. Gladyshevskii (L'vov State Univ.). Zh. Strukt. Khim., 5: 919-21(Nov.-Dec. 1964). (In Russian)

X-ray analysis was made of the crystal structure of all rare earth powders (except Pm) melted with Ge_3 in a helium atmosphere in an electric arc furnace and annealed for 50 hr at 500°C. The prepared alloys (except Eu and Yb) formed R_5Ge_3 compounds with Mn_5Si_3 type structure. Neither Eu or Yb formed the Mn_5Si type compounds. Further studies were initiated to determine their crystal structures. (R.V.J.)

11763 THEORY OF DEFECTS IN METALS. J. Friedel (Université de Paris, Orsay, France). p.114-46 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The electronic structure of metals and the main ensuing properties of their defects are discussed. Emphasis was placed on stationary defects, which break up the periodicity of perfect crystals. They can be grouped into three classes: point defects, line defects, and surface defects. Each type is described and examples given. (M.C.G.)

11764 QUENCHED-IN LATTICE DEFECTS IN METAL. Elio Germagnoli (Laboratori C.I.S.E., Milan and Università, Parma, Italy). p.240-60 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Concentrations of lattice vacancies and interstitials in metals and activation energy for migration of vacancies were studied. Quenching experiments were used to investigate the activation energy for vacancies. Annealing kinetics and recovery of quenched-in vacancies are discussed. (62 references) (M.C.G.)

11765 THE ADSORPTION OF RADIOACTIVE IODINE ON TO AN IRON OXIDE AEROSOL AS A FUNCTION OF PARTICLE SIZE. D. K. Craig (Atomic Energy Board, Pretoria). p.159-72 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

An experimental apparatus that was constructed and the techniques that were adopted to investigate the relationship between adsorption activity and particle size for fission product radionuclides and artificially generated aerosols is described. Filtered and conditioned air is passed through a one cubic meter aerosol chamber at a constant rate. The test aerosol and radionuclides are also introduced into the chamber at constant rates. Samples are drawn periodically to determine the aerosol concentration and particle size distribution. A concurrent sample is drawn from the chamber with a Goetz aerosol spectrometer, and analysis of this enables the amount of activity adsorbed on to particles in predetermined size ranges to be measured. Preliminary results obtained using an iron oxide aerosol and iodine-131 in the form of sodium iodide molecules as the radionuclides indicate that the gross activity adsorbed on to all particles of different sizes in a log-normally distributed aerosol varies by less than an order of magnitude. However, the actual number of molecules per particle seems to be a complex function of aerosol particle size that will require further investigation to elucidate. (P.C.H.)

11766 NEUTRON INVESTIGATION OF MAGNON SPECTRUM IN HEMATITE. Z. Dimitrijevic (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia), H. Rzany, J. Todorovic, and A. Wanic. Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/29, 14p. (CONF-804-18)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Measurements were made on the RA reactor, using a crystal neutron spectrometer. Monochromatic neutrons (λ = 1.314 Å) were scattered on a large single crystal of hematite ($\alpha-Fe_2O_3$). The angular distributions of inelastically scattered neutrons were investigated. For a number of different crystal missetting angles $\Delta\vartheta$ the width Γ of the scattered neutron beam (so-called scattering cone) was measured. This scattering cone was ascribed to the magnon scattering surface surrounding the (111) reciprocal lattice point. For several magnon velocities the Γ versus missetting angle dependence was calculated and compared with the experimental points. The velocity in the (111) direction was found to be 25.5 ± 1.0 km/sec. Structural anisotropy of the magnon dispersion relation was discovered. The velocity was found to be higher for the directions of propagation parallel to the (111) axis in qualitative agreement with previous measurements giving v = 38 km/sec. It was not possible to reveal the existence of an energy gap E_g in the acoustic magnon energy band. It was estimated that the E_g value must be below 1 Mev. Using the formalism of Wallace, the magnon dispersion relations in hematite were calculated under the assumption that there exist two non-vanishing exchange integrals J_1 and J_2, which denote the superexchange energy coupling between the spins of neighboring iron ions bonded via an oxygen ion. The Fe–O–Fe angles of the bonds taken into consideration are correspondingly 132 and 126°. Satisfactory agreement between the theory and existing experimental data is obtained when $SJ_1 = SJ_2 = -5.9$ Mev. Apart from the acoustic magnon branch, the calculations revealed the existence of an optic branch, but this was not accessible to investigation by the neutron diffraction technique. (auth)

11767 THERMAL VIBRATIONS OF BETA-BRASS AND THE ORDER-DISORDER TRANSITION. G. Dolling and G. Gilat (Atomic Energy of Canada Ltd., Chalk River, Ont.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/5, 24p. (CONF-804-22)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Observations of normal modes of vibration of the ordered alloy of copper and zinc, β-brass, at 296°K were made by means of the coherent one-phonon scattering of slow neutrons from single crystal specimens. The triple axis crystal spectrometer at the NRU reactor was used to measure the frequencies of modes propagating along the high-symmetry directions [00ξ], [$\xi\xi$0], [$\xi\xi\xi$], and [$\frac{1}{2}\frac{1}{2}\xi$]. The dispersion curves resemble those of a simple body-centered cubic crystal such as Na, except that certain degeneracies are lifted, mainly by reason of the difference between the second nearest neighbor Cu–Cu and Zn–Zn forces. For example, two distinct modes of wave vector (0.5, 0.5, 0.5) (in reciprocal lattice units) with frequencies of (4.21 ± 0.06) and $(4.93 \pm 0.10) \times 10^{12}$ cps, respectively, were found. Interatomic force models which provide a satisfactory description of the 296°K results are briefly mentioned. Several normal modes were studied at elevated temperatures, particularly in the vicinity of the order-disorder phase transition at about 727°K. There are no striking changes in the overall structure of the dispersion curves as a result of the vanishing of the long-range order at this temperature, although the various "splittings" observed at 296°K are blurred out into more or less continuous "bands" of frequencies. As the temperature rises, the frequencies generally decrease, and the energy widths increase. These changes take place in a smooth manner, except for two longitudinal optic modes, observed at positions (1.27, 1.27, 0) and (1.2, 1.2, 0.2) in reciprocal space, which display sharp increases in energy width at the transition temperature. No reasonable explanation of these effects has yet been found. (auth)

11768 COMPARISON OF SPIN WAVE THEORY WITH NEUTRON SCATTERING RESULTS FOR MnF_2. G. G. Low (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/38, 9p. (CONF-804-14)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Recent inelastic neutron scattering experiments carried out by Okazaki and Turberfield have provided a direct measure of spin wave dispersion in MnF_2, both at 4.2°K and at higher temperatures approaching the Néel point. The low temperature results taken together with other magnetic data allow the various exchange constants in MnF_2 to be evaluated with some precision. Using these constants, the spin wave formalism for anti-ferromagnets described by Oguchi was employed to predict theoretically the temperature dependence of the spin wave dispersion. No disposable parameters are involved and theoretical dispersion curves may be compared with the experimental results for higher temperatures as a test of the spin wave theory. The spin wave energies were evaluated numerically and integrations over the Brillouin zone were performed, thus avoiding the use of some form of series expansion in temperature. Account was taken of dynamical interactions between pairs of spin waves, but kinematical effects were neglected. Renormalization of the spin-wave energies was performed. This is an important factor for $T/T_N \gtrsim \frac{1}{4}$. The agreement between theory and experiment is remarkably good up to temperatures corresponding to about 90% of the Néel point. It would be dangerous to extrapolate this result to systems of lower spin as kinematical effects are likely to play a much greater part in such cases. For MnF_2 where $S = \frac{5}{2}$ a rough estimate suggests that kinematical effects will not be important until $M/M_0 \sim 20\%$, and this occurs only within a degree or so of the Néel point. A brief discussion of the likely consequences of a biquadratic exchange term in MnF_2 is given; and it is concluded that, if present, such exchange is quite small. (auth)

11769 ANHARMONIC EFFECTS AND THE SCATTERING OF NEUTRONS FROM A CRYSTAL. R. A. Cowley (Cambridge Univ., Eng. and Atomic Energy of Canada Ltd., Chalk River, Ont.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/8, 24p. (CONF-804-24)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The effects of the anharmonic interactions between the normal modes of vibration of a crystal on the inelastically scattered neutron distributions have been discussed by several authors. It is well known that they give rise to temperature dependent widths and frequencies for the scattered neutron groups. It is less well known that both the frequency and the lifetime of a normal mode depend not only on the temperature, but also on the "applied" frequency used to study the normal mode. As a result of this frequency dependence, the scattered neutron groups may have a more complex structure than a simple Lorentzian shape. Furthermore, if the eigenvectors of the normal mode are not completely determined by the symmetry of the crystal they cannot be considered as independent. The interference between them will depend on both the temperature and the applied frequency. In most crystals these effects are small at temperatures well below the melting point. However, in certain crystals, ferroelectrics for example, some of the modes are anomalously temperature-dependent so that these effects may be larger. Calculations were made of these effects using a model of strontium titanate. The results, which give reasonable agreement with the temperature dependence of the modes, the infra-red reflectivity and thermal expansion, show that the effects of the frequency dependence of the modes and of the interference of the different normal modes are by no means negligible. (auth)

11770 PHONONS IN WHITE TIN. D. Long-Price (Cambridge Univ., Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/39, 12p. (CONF-804-15)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Phonons were studied in white tin with slow neutrons on a time-of-flight apparatus. The frequencies of about 700 phonons in the (100) and (001) planes were measured at room temperature. Dispersion curves along symmetry directions are compared with those predicted from a model of Musgrave and with predictions from other models. (auth)

11771 MAGNETORESISTANCE OF BISMUTH. A. M. Forrest and A. C. Hollis Hallett (Univ. of Toronto). 7p. (CONF-651-38)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.–Sept. 1964.

The resistance of single crystals of bismuth was measured at 1.2°K along the trigonal axis while various constant magnetic fields up to about 18 kilogauss were rotated in the plane perpendicular to that axis. Specimens with resistance ratios as large as 1000 (in the earth's magnetic field) were prepared. The resistance measurements were made by conventional methods using a potentiometer. (H.D.R.)

11772 LONGITUDINAL MAGNETORESISTANCE OF COPPER. Robert L. Powell (National Bureau of Standards, Boulder, Colo.). 9p. (CONF-651-34)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.–Sept. 1964.

Single crystals of copper were prepared that were aligned to a given crystallographic direction within 0.1° or better. Galvanomagnetic measurements were made on samples with orientations of 100, 111, 110, 321, and 521 and with residual resistance ratios of 630 to 1520. (H.D.R.)

11773 THE ELECTRONIC MEAN FREE PATH AND THE AREA OF THE FERMI SURFACE IN ALUMINIUM AND INDIUM. G. Braendli, P. Cotti, E. M. Fryer, and J. L. Olsen (Eidgenossische Technische Hochschule, Zurich). 7p. (CONF-651-40)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio.

Values of the ratio of conductivity to mean free path were measured by an eddy current method for 5 indium specimens and 2 aluminum specimens. The fraction of specular reflection at specimen boundaries was calculated and used in investigating the mean free path and Fermi surface area. (H.D.R.)

11774 DE HAAS-VAN ALPHEN EFFECT IN β'-CuZn. J.-P. Jan, W. B. Pearson, and M. Springford (National Research Council, Ottawa). 9p. (CONF-651-33)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

A pulsed field technique was used to observe the de Haas-van Alphen oscillations of the low temperature magnetic susceptibility of β'-CuZn samples at the equiatomic composition. The de Haas-van Alphen effect is recorded as a function of crystallographic orientation, and the frequencies are converted to extremal cross sections of the Fermi surface. A model is proposed to explain the results. (H.D.R.)

11775 INELASTIC IMPURITY SCATTERING OF ELECTRONS IN GOLD ALLOYS AT LOW TEMPERATURES. D. H. Damon and P. G. Klemens (Westinghouse Electric Corp., Pittsburgh). 10p. (CONF-651-35)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The residual resistivity of some binary gold alloys with copper and platinum was measured from 1.5 to 40°K. The data were used to plot deviations from Matthiessen's rule and to investigate a possible contribution of phonon-assisted impurity scattering to the resistance. (H.D.R.)

Radiation Effects

Refer also to abstracts 11378, 11471, and 11727.

11776 (AERE-R-4690) THE MEASUREMENT OF THE THERMAL CONDUCTIVITY OF UO_2 UNDER IRRADIATION IN THE TEMPERATURE RANGE 150°-1600°C. D. J. Clough and J. B. Sayers (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1964. 75p. Dep.

Two experiments to measure the thermal conductivity of polycrystalline sintered uranium dioxide continuously under irradiation by a radial heat flow method are described. The capsules were designed to give accurate control over a range of temperatures and to permit continuous measurement of the heat output from the specimen. Thermocouples were located both in the center line and circumferential positions in the fuel to eliminate corrections for the thermal resistance of the fuel can interface. In the first experiment, in which the fuel operated under similar rating and temperature conditions as in the Windscale AGR, no significant change in thermal conductivity was evident in the temperature range 500-1600°C up to a maximum dose of 4×10^{19} fissions/cc. For the majority of the irradiation the fuel operated in the temperature range 700-1200°C; measurements below 700°C were obtained during the periods at reduced power during successive reactor start ups. Above 1200°C comparative values were obtained in a short period of operation in a higher flux position, the dose accumulated in this position being only 5×10^{16} fissions/cc. The second experiment investigated the irradiation effects at lower temperatures covering the range 150-800°C. At a mean fuel temperature of 180°C, a decrease in thermal conductivity of 25% occurred after a dose of 1.5×10^{19} fissions/cc, compared with a 20% decrease after the same burnup at a mean temperature of 320°C. A large proportion of the total reduction in conductivity occurred below an accumulated dose of 5×10^{17} fissions/cc and the damage effects tend to saturate at doses in excess of 5×10^{18} fissions/cc. No measurable change in thermal conductivity was detected in a specimen irradiated at a mean fuel temperature of 520°C up to a dose of 4×10^{19} fissions/cc. Annealing experiments showed that at intermediate dose levels ($10^{18}-5 \times 10^{18}$ fissions/cc) a large fraction of the damage inserted at 180 and 320°C could be recovered by annealing at 450 and 750°C respectively. As irradiation proceeded, the fractional recovery that could be obtained decreased and above 10^{19} fission/cc little or no recovery was evident. (auth)

11777 (EURAEC-1243) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Seventh Quarterly Report. W. Siegfried and S. Zimering (Battelle Memorial Inst. International Div., Geneva). Dec. 1964. Work Performed under United States-Euratom Joint Research and Development Program. Contract 100-62-12 RDS. 52p. Dep.(mn); $3.00(cy), 1(mn) OTS.

In the application of the exponential function of real order to the description of the creep process, the isothermal extrapolation was completed. Mathematical criteria were developed in order to verify whether a given sequence of experimental data is sufficient to determine an exponential function. Summaries are given of the discussions of problems and experiences in in-pile creep tests, which were presented in the Euratom Technical Meeting at Battelle, Geneva, August 27 to 28, 1964. The published work of Gusev et al. is discussed. Finally, the research program is outlined. (D.L.C.)

11778 (EURAEC-1268) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Final Report. W. Siegfried and S. Zimering (Battelle Memorial Inst. International Div., Geneva). Dec. 1964. Work Performed under United States-Euratom Joint Research and Development Program. Contract 100-62-12 RDS. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An improved method for extrapolation of time-to-rupture tests was developed. The verification of the method by long-duration tests is discussed. A description is given of a model which was developed for the deformation and the propagation of grain boundary fissures in a polycrystalline material. The conditions under which the extrapolation method is valid for neutron irradiation are outlined. (D.L.C.)

11779 (HW-71500B) THE H-3 IRRADIATION EXPERIMENT: IRRADIATION OF EGCR GRAPHITE. Interim Report No. 2. J. W. Helm (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 109p. Dep.; $4.00(OTS).

Irradiations are being performed in the GETR to determine the long-term stability of EGCR graphite. The results from the first seven experiments with a maximum peak neutron exposure equivalent to 70,000 Mwd/adjacent ton in the EGCR are now available. The capsules contained samples of EGCR graphite and reference CSF graphite. The samples were irradiated sequentially to increase the neutron exposure on the samples. The basic H-3 capsule design utilizes the gamma heating in the E7 position of the GETR to achieve the desired operating temperatures. Samples were irradiated in a temperature range of 375 to 850°C. The contraction of the graphites tested continued to show a dependence on the temperature of irradiation. The parallel samples contracted at an increasing rate with increasing exposure. Results indicated no differences in contraction rate for parallel samples taken from several positions in the large block. The transverse samples contracted less than the parallel samples and one sample, at 800°C irradiation temperature, expanded back past the original length in the last two irradiation periods. Data on the changes with continued irradiation of volume, crystallite parameters, Young's modulus, and electrical resistivity are presented. (D.L.C.)

11780 (NRL-6179) YANKEE REACTOR PRESSURE VESSEL SURVEILLANCE: EVALUATION OF SPECIMENS EXPOSED DURING THE SECOND CORE. C. Z. Serpan,

Jr., H. E. Watson, J. R. Hawthorne, and L. E. Steele (Naval Research Lab., Washington, D. C.). Sept. 18, 1964. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Pressure vessel surveillance specimens from four capsules in accelerated irradiation positions of the Yankee Atomic Power Reactor were tested. In spite of the fact that the four capsules were located in physically identical positions about the fuel core, they were subject to widely different neutron exposures (>1 Mev). The Charpy-V transition temperature increase of the Yankee pressure vessel steel, which was irradiated together with a reference steel of the same nominal composition in the same capsules, was somewhat larger than the increase of the reference steel. The data from the reference steel followed closely the trend line of transition temperature increase versus total neutron exposure previously established by NRL for 540°F irradiations, but that for the Yankee vessel steel was displaced almost 100°F higher than the reference steel. Postirradiation annealing was beneficial for the three heat treatment conditions studied, and, in one case, essentially complete recovery of initial properties was observed. The study demonstrated the usefulness of accurate dosimetry data for each surveillance specimen and the importance of measurements of the neutron dosage to which the monitored reactor component is exposed. (auth)

11781 (NRL-Memo-1556) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS (1 MAY 1964–31 JULY 1964). L. E. Steele, J. R. Hawthorne, and C. Z. Serpan, Jr. (Naval Research Lab., Washington, D. C.). Aug. 15, 1964. Contract AT(49-5)-2110. 40p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Data are presented on the following: (1) microstructural examination of uranium-bearing steels, (2) comparison of effects of simultaneous irradiation of six structural steels, (3) radiation damage surveillance of Yankee Atomic Power Plant pressure vessel, (4) activation of new High Level Radiation Laboratory, and (5) techniques and equipment for in-reactor studies of low cycle fatigue of metals. (D.L.C.)

11782 (ORNL-TM-1011) PROPERTIES OF BeO COMPACTS IRRADIATED TO FAST-NEUTRON DOSES GREATER THAN 10^{21} NEUTRONS/cm^2 AT 110, 650, AND 1100°C. G. W. Keilholtz, J. E. Lee, Jr., and R. E. Moore (Oak Ridge National Lab., Tenn.). Dec. 1, 1964. Contract [W-7405-eng-26]. 31p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The behavior of BeO sintered compacts toward fast-neutron doses was studied over the flux range 1.3 to 5.7 × 10^{14} neutrons/cm^2-sec. Four types of specimens consisting of two densities (2.7 and 2.9 g/cm^3) and two grain sizes (~ 22 and 34 to 72 μ) were included. At 110°C, there was severe fracturing of specimens, and most samples disintegrated to powder after doses exceeding 2 × 10^{21} neutrons/cm^2. Volume expansion increased from 2.5 to 6% over the dose range 0.7 to 2.2 × 10^{21} neutrons/cm^2. In comparison, crystal volume expansion calculated from lattice parameters increased only from 1.25 to 3.5% over the same dose range, indicating that grain-boundary separation accounts for about 50% of the volume increase of compacts. Anisotropic crystal expansion is the principal mechanism causing grain boundary separation in BeO compacts irradiated at low temperatures or to high doses at high temperatures. In-pile annealing of fast-neutron damage to BeO occurs to some extent at 650°C and is most effective at 1100°C. Some specimens irradiated at 1100°C disintegrated to powder after doses greater than 4 × 10^{21} neutrons/cm^2. No flux intensity effect on gross damage, volume expansion, or lattice parameter expansion is apparent for samples irradiated at 650°C for different time periods at equivalent dose values. In irradiations at 1100°C, there is no apparent flux intensity effect on gross damage. However, volume expansion was greater in low fluxes than in high fluxes for equivalent doses. It is suggested that thermal cycling of the reactor in a long-term, low-flux irradiation can produce grain boundary separation in compacts with anisotropically strained grain boundaries. (D.L.C.)

11783 STAGE III DEFECT ANNEALING IN SINGLE CRYSTALS OF ALUMINIUM AND GOLD. T. S. Hutchinson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Appl. Phys. Letters, 6: 22-4(Jan. 1, 1965).

Ultrasonic attenuation at megacycle frequencies and low strain amplitudes was measured on warmup of crystals of aluminum and gold following gamma irradiation at 80°K. Just prior to cooling the crystals were plastically deformed, creating vacancy pinning of the dislocations. Variations in the ultrasonic attenuation, in principle, are influenced only by that part of the annealing involving defect migration over appreciable distances. The results suggest that an interstitial-like defect migrates in stage III in both Al and Au. (H.D.R.)

11784 ANNEALING EXPERIMENTS ON REACTOR IRRADIATED p-TYPE GERMANIUM. Goesta Swenson (Chalmers Tekniska Högskola, Göteborg). Arkiv Fysik, 28: 67-83(1964).

The effects of irradiation and the annealing behavior (in terms of Hall coefficient and resistivity) for a series of high-purity Ge samples that were exposed in a reactor were investigated. The effective hole mass was set at 0.3 M_e where M_e is the free electron mass. This estimate is based on cyclotron resonance measurements. (J.R.D.)

11785 MEASUREMENT OF DOSE RATE DISTRIBUTION BY GLASS DOSIMETRY. Hiroshi Suguro and Yoshiharu Shinozaki (Tokyo Metropolitan Isotope Center). Doitai To Hoshasen, 4: 383-6(Dec. 1962). (In Japanese)

A simple method using a modified glass dosimetry was devised to measure the dose rate distribution around a 1000-Curie source of irradiation. Glass with the quality of a deck glass, thickness 1.5 mm, was cut into pieces 25 × 157 mm each and set parallel to the source. Irradiation was made at two different positions, 25 and 50 mm from the source, and the optical density of the irradiated sample at 400 mμ was measured by a photoelectric photometer, with a densitometric attachment. A cylindrical zone of homogeneous dose rate about 100 mm long was found to exist around the ^{60}Co source. As fading was observed in all irradiated samples, its effect on the applicability of this method was investigated at various conditions. The rate of fading in irradiated glass was measured by its optical density at various temperatures, 23, 64, 100, and 130°C, and the apparent activation energy of the fading was calculated both in an initial state and when the optical density had decreased to one half of the initial value. The results show that this fading sometimes causes an error in the determination of absolute dose rate, but that the error is negligible in the measurement of relative dose rate distribution. (auth)

11786 DEFECT LEVELS PRODUCED IN GERMANIUM BY MONOENERGETIC NEUTRONS. R. F. Konopleva, S. R. Novikov, and S. M. Ryvkin. Fiz. Tverd. Tela, 6: 2022-5 (1961).

The energy spectrum of defect levels of Ge irradiated with monoenergetic neutrons at 14 and 4 to 5 Mev was investigated. The donor concentration of n-type samples was 3 × 10^{13} and 2 × 10^{15} cm^{-3}. The inverse temperature dependence of the Hall effect measured at 77 to 300°K revealed the presence of the $E_c - 0.2$, $E_v + 0.18$, and $E_v + 0.07$ ev defect levels. These levels correspond to three of the four upper defect levels produced in Ge irradiated with fast neutrons in a reactor, which were reported in an earlier paper (Fizika tverdogo tela, v. 5, no. 7, 1963, 1842-1851). The formation rate of defects per incident neutron was found to be ~2 for all three defect levels. The rate of introduction and the dimensions of the disordered regions and their contribution to the initial rate of removal of charge carriers from the conduction band were also calculated. It was concluded that the defect-level energy spectrum produced in Ge by neutrons is probably independent of the energies of the neutrons. (auth)

11787 EFFECTS OF γ-IRRADIATION ON CATION EXCHANGE RESINS. Tadayoshi Kubodera and Masamichi Ideka (Tokyo Metropolitan Isotope Center). Isotopes Radiation (Tokyo), 4: 387-92(Dec. 1962). (In Japanese)

The effects of ^{60}Co γ irradiation on the exchange capacity, swelling characteristics and oxidizability of cation exchange resins were studied. Air-dry and wet cation exchange resins, Diaion SK 1, were irradiated (up to 6×10^7R) in H, Na, Fe, and Pb forms. Radiation caused a decrease of exchange capacity of the resins. The rate of decrease was highest in H form (6% at 5×10^7R) than Na form, Fe form, and lowest in Pb form. The effects of irradiation on the swelling characteristics of the resins were not remarkable throughout the whole range of radiation doses applied, except for H form resin. In this case, the swelling decreased remarkably at a dose over 6×10^7R in a dry state, while it decreased only a little in a wet state. Pb form resin seemed most stable against radiation, both in dry and wet states. In Fe form resin, functional groups lost by irradiation of 6×10^7R corresponded to the total amount of ferrous and ferric ions liberated from the resin into water. (auth)

11788 EFFECTS OF IONIZING RADIATION DIELECTRIC LOSSES. V. K. Zhuravlev (Tomsk Polytechnic Inst., USSR). Izv. Vysshikh. Uchebn. Zavedenii, Fiz., No. 5, 86-90(1964). (In Russian)

Effects of a low intensity radiation on polarization relaxation were studied without considering irreversible dielectric changes. The appearance of hot molecules taking place at the expense of radiation energy absorption may increase or decrease dielectric relaxation as well as increase or decrease dielectric losses (tr-auth)

11789 THE ANNEALING AND RECOVERY OF RADIATION-DAMAGED MILD STEEL. E. O. Hall, B. Abbott, J. W. Eltis, and R. H. Forster (Newcastle University Coll., New South Wales). J. Australian Inst. Metals, 9: 264-8(Nov. 1964).

A study was made of the yield stress of samples of radiation-damaged mild steel, which was subjected to annealing treatments at 350, 300, and 250°C. Analysis of the stress-strain curves and recovery of the yield stress showed that elimination of the point defects arising from irradiation is a complex affair and is not a singly activated process. (auth)

11790 AN APPARATUS FOR GALVANOMAGNETIC MEASUREMENTS OF SEMICONDUCTORS IRRADIATED IN A NUCLEAR REACTOR. V. P. Bilenskii, Yu. M. Rezanov, and U. A. Ulmanis (Inst. of Physics, Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad., Vestis, Fiz. Tek. Zinatnu Ser., No. 4, 3-5(1964). (In Russian)

An electromagnet-containing device for studying the Hall effect and electrical resistance of semiconductors placed in magnetic fields and irradiated within reactors is described. The magnetic field within the 1 mm gap can be as high as 10^4 Oe. The temperature of the sample may be varied between 25 and 200°C. The entire device is mounted within a cadmium ϕ = 50 mm container and it can be lowered into the vertical experimental channels of a reactor. The operation of the device is described, and some experimental results obtained during irradiation of germanium samples in the 1,700-kw IRT-2000 nuclear reactor are presented. (OTS)

11791 RELATIONS BETWEEN THE REPETITION OF HEAT-TREATMENTS DURING IRRADIATION AND RADIATION EFFECT ON THE TENSILE PROPERTIES OF LOW DENSITY POLYETHYLENE. Yoshinori Tsunekawa and Jobu Awatani (Osaka Univ.). Mem. Inst. Sci. Ind. Res., Osaka Univ., 21: 127-9(Mar. 1964).

Specimens of low-density polyethylene sheet were irradiated with gamma rays from cobalt-60 while immersed in water and then were heat-treated in boiling water for one hour to stabilize the polyethylene materials. Some specimens were heat-treated at 100°C for one hour at a time whenever the irradiation dose reached one tenth of the appointed dose. Tensile tests were performed by an Instron Tester at a tensile rate of 100%/min at a constant temperature of 30°C. The results showed that the yield point ratios became higher, but the elongations at break decreased when the specimens were heat-treated ten times. (auth)

11792 INTEGRITY OF METALLIC REACTOR FUELS. Sigfred Peterson. Nucl. Safety, 6: No. 1, 38-40(1964).

The radiation stability of metallic fuels is discussed. Uranium-base fuels, thorium-base fuels, aluminum-base fuels, and cermets containing UO_2 are considered. (M.C.G.)

11793 OXIDATION OF GRAPHITE. Sigfred Peterson. Nucl. Safety, 6: No. 1, 40-1(1964).

The reactions of graphite with oxygen, carbon dioxide, and steam are discussed. Studies on the dependence of the reaction rate on oxygen pressure are reviewed. One effect of irradiation on the oxidation of graphite was traced to the immobilization of catalytic impurities. (M.C.G.)

11794 ELECTRON-PARAMAGNETIC RESONANCE ABSORPTION STUDIES OF NEUTRON-IRRADIATED LiF AT TEMPERATURES ABOVE 300°K. M. Misakian and Y. W. Kim (Wayne State Univ., Detroit). Phys. Rev., 137: A1226-33(Feb. 15, 1965). (TID-20167)

Electron-paramagnetic resonance (EPR) absorption of irradiated LiF was investigated at controlled temperatures. The samples have received neutron doses ranging between 2.4×10^{15} and 1×10^{19} nvt. The temperature of the samples was varied from 300 to near 600°K. The experimental results have indicated the need of distinguishing the following three neutron-dose ranges: a light-dose range (2.4×10^{15} nvt and probably less), a medium-dose range (2.4×10^{16} through 1×10^{18} nvt), and a heavy-dose range (1×10^{19} nvt and probably larger). The dependence of EPR spectra on the temperature was described in terms of three characteristic temperatures T_1, T_2, and T_3. To explain the results, the two-center model was adopted, and the activation energy for the diffusion of F centers was assumed to be dependent on the concentration of F centers. Some difficulties, however, were encountered in the application of the two-center model. A possible solution of these difficulties is considered. (auth)

11795 STORED-ENERGY RELEASE BELOW 80°K IN DEUTERON-IRRADIATED COPPER. T. G. Nilan and A. V. Granato (Univ. of Illinois, Urbana). Phys. Rev., 137: A1233-49(Feb. 15, 1965).

Measurements were made of the release of stored energy during the annealing from 15 to 80°K of copper irradiated with 11-Mev deuterons. A differential thermometry technique using two closely matched specimens, one of which was irradiated, was employed. Loss corrections and heat capacities were determined for the range of temperature of annealing. Two irradiations, with different total damage dose, and subsequent anneals were made. Good definition of the peak substructure in stage I was obtained. The magnitude of the energy released is consistent with the interstitial-vacancy annihilation mechanism of radiation damage annealing. The energy-to-resistivity ratio found is in disagreement with the ratios obtained previously for neutron and electron damage. Assignments are obtained for the volume change, resistivity, and number of Frenkel pairs introduced in a damaged copper specimen for a given assumed value of the energy of a Frenkel pair. The results are compared with theory. (auth)

11796 CONCENTRATION DEPENDENCE OF STAGE I ANNEALING IN IRRADIATED COPPER. A. V. Granato and T. G. Nilan (Univ. of Illinois, Urbana). Phys. Rev., 137: A1250-67(Feb. 15, 1965). (TID-20554)

An analysis is given of the radiation-damage annealing to be expected under conditions of constant warmup rate. It is found that third-order kinetics are to be expected for defects moving freely in one dimension. A discussion is given of the Wigner catastrophic annealing effect. Using the analysis, a detailed discussion is given of the annealing curves found for stored energy released on annealing deuteron-irradiated copper in stage I. Most of the conclusions reached previously by Magnuson, Palmer, and Koehler and by Corbett, Smith, and Walker using resistance measurements are confirmed. Evidence for the existence

of clusters of damage in deuteron-irradiated specimens is found. Peak I_E is found to follow second-order kinetics, providing evidence against the possibility of freely migrating interstitials in one dimension. It is found that peak I_D cannot be interpreted with a unique activation energy and is interpreted instead as a superposition of additional close Frenkel pairs. Using a combination of deuteron and electron damage measurements, a value of the energy-to-resistivity ratio for Frenkel pairs is found for peak I_E which agrees within experimental error with that found for stage I using deuteron results alone. (auth)

11797 ELECTRICAL RESISTIVITY VARIATION PRODUCED BY DISPLACEMENT CASCADES, GENERATED BY IRRADIATION. A. Corciovei and A. Babcenco (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 5-22(1964). (In French)

It is shown that the total variation of the resistivity of an irradiated metal, where cascades of displaced atoms not superposed on one another are produced, is equal to the sum of the variations of resistivity due to each individual cascade. By utilization of the distribution functions of the interstices or of vacancies of a cascade engendered by a primary atom produced by irradiation, the variation of resistivity due to a single cascade was calculated. It is shown that this variation of resistivity is less than the variation of resistivity that would be produced in a metal by a number of independent interstice-vacancy pairs, equal to the number of interstices or vacancies of the cascade considered. (tr-auth)

11798 RADIATION EFFECTS ON ADHESIVES. Kimio Ito (Mitsubishi Electric Mfg. Co., Japan). Setchaku, 63: No. 10, 15-21(Oct. 1963). (In Japanese)

When organic substances are irradiated, the intermolecular crosslinking and the degradation proceed at complex rates and physical properties are changed. The radiation effect is directly proportional to the radiation dose and does not depend on the dose rate. In the grafting reaction, the disintegration and degradation take place at high doses, depending on the conditions. Epoxide resin or vinyl-phenol resin type adhesives start to degrade about 10^7 Rad. This degradation is considered to be due to the excitation and ionization effect of the radiation rather than to the heat or oxygen effect. Nuclear reactors and radiation generators are usually designed not to use these organic substances. But, if the extents of the degradation are known, these substances, for example, the adhesives, are very useful. (Nucl. Sci. Abstr. Japan, 3: July 1964)

11799 PHOTOCONDUCTIVITY OF GERMANIUM IRRADIATED BY FAST NEUTRONS AT 77°K. S. R. Novikov and É. É. Rubinova (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 1037-40(Nov. 1964). Translated from Fiz. Tverd. Tela, 6: 1328-32(May 1964).

The spectral dependence of the photoconductivity of n- and p-type Ge irradiated by fast neutrons in a reactor at 77°K and annealed at higher temperatures was studied. The locations of energy levels observed at various stages of the annealing process are presented. An attempt is made to determine whether the energy levels have donor or acceptor characteristics. (auth)

11800 COLOR CENTERS IN SODIUM ALUMINOSILICATE GLASSES. G. O. Karapetyan, S. A. Stepanov, and D. M. Yudin (Vavilov State Optical Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 1197-1203 (Nov. 1964). Translated from Fiz. Tverd. Tela, 6: 1531-9 (May 1964).

The EPR and additive optical absorption spectra of ^{60}Co γ irradiated sodium aluminosilicate glass systems were investigated. The EPR spectra were taken of samples of 20% $Na_2O \cdot x\%$ $Al_2O_3 \cdot (80-x)\%$ SiO_2. The experimental data are explained in terms of working models of the traps produced. (auth)

11801 DETERMINATION OF THE GENERATION RATE OF A-CENTERS IN IRRADIATED SINGLE CRYSTALS OF SILICON IN THE 9-μ ABSORPTION BAND. É. N. Lotkova (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 6: 1224-5(Nov. 1964). Translated from Fiz. Tverd. Tela, 6: 1559-60(May 1964).

The role of O atoms in the formation of A-center radiation defects in Si monocrystals was studied. The Si crystal was irradiated with doses of 3×10^{17} to 5×10^{19} fast neutrons/cm^2. It was found that, after the O in SiO_4 complexes is exhausted, the interstitial O atoms begin to take part in the formation of A-centers and the 9μ absorption decreases. (M.J.T.)

11802 SOME DATA ON RADIATION DEFECTS OBTAINED BY STUDYING THE PHOTOCONDUCTIVITY SPECTRA OF GERMANIUM IRRADIATED BY FAST ELECTRONS. I. P. Akimchenko, V. S. Vavilov, and A. F. Plotnikov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 6: 1348-52(Dec. 1964). Translated from Fiz. Tverd. Tela, 6: 1718-23(June 1964).

The photoconductivity spectra of p- and n-type germanium irradiated by 1 Mev electrons is investigated in the 1.8 to 10 μ region. Additional experimental support is given to the previously advanced hypothesis that the $E_v + 0.42$ ev level is associated with isolated interstitial atoms. It is shown that the $E_v + 0.33$ ev level in unirradiated p-type samples with residual impurity concentrations in the 10^{11} to 10^{13} atoms/cm^3 range belongs to copper atoms. In irradiated samples the level at $E_v + 0.33$ ev is clearly associated with a complex involving a copper atom and a vacancy. The capture cross section of holes on this level is equal to 5×10^{-19} cm^2 at 100°K. (auth)

11803 HIGH TEMPERATURE ANNEALING OF GAMMA-RADIATION DEFECTS IN n-TYPE GERMANIUM. N. A. Vitovskii, T. V. Mashovets, and S. M. Ryvkin (Inst. of Technical Physics, Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 1481-8(Dec. 1964). Translated from Fiz. Tverd. Tela, 6: 1883-92(June 1964).

It is shown that the recombination of donor and acceptor components of defects (bipolar annealing) constitutes the main process in the annealing of γ-radiation defects in germanium. Furthermore, under different conditions, it is possible to observe monopolar annealing of the donor or the acceptor component. During the annealing process there is a simultaneous decrease in defect concentration and change in the energy structure of the defects. (auth)

11804 TRANSIENT EFFECT OF INDUCED CURRENT IN POLYMER INSULATOR UNDER IRRADIATION OF HIGH ELECTRON BEAM. Kichinosuke Yahagi (Saseda Univ., Japan). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 24, 49-53(Sept. 1963).

Films of polyethylene and polytetrafluoroethylene were irradiated in vacuum by high-energy electrons from a Van de Graaff accelerator and the change in the electric conductivity was measured during and a little after irradiation. The intensities of the electron beams used were about 10^7 to 10^8 Rad/hr, and the irradiation lasted about 10 seconds. The voltages applied to the specimens were 90 and 540 volts and the induced and decaying currents were recorded by a recording micro-micro ammeter. The domination of the bimolecular recombination of the current carriers was suggested and the following relation was found between the dose rate, R, and the carrier concentration in the stationary state during irradiation, n_0; $n_0 \propto R^{0.6 \sim 0.65}$. It may be concluded from the temperature dependence of the decaying characteristics that the thermal release of the current carriers from the traps decreases considerably with the freezing of the segmental motion in the amorphous parts at low temperature. The decay became faster when the irradiation was repeated, and the phenomenon was explained by the space charge or deep trap formation, etc. The existence of an internal field (by the space charge) was shown by determining the electrostatic charge in the specimen after irradiation. The growth of deep traps after irradiation was shown by the change in the dose-rate dependence of the induced current in a specimen irradiated with gamma rays. (Nucl. Sci. Abstr. Japan, 3: July 1964)

11805 RADIATION SHIELDING PROPERTIES OF GLASSES IN THE SYSTEM $Li_2O-PbO-B_2O_3$. Toshio Sugiura and Keiichi Murakami (Tohoku Univ., Sendai). Yogyo Kyokai Shi, 72: 63-6(May 1964). (In Japanese)

Properties of glasses in the system $Li_2O-PbO-B_2O_3$ were investigated for application as radiation shielding material. This system was selected because of the large cross section of boron for neutrons, high absorption property of lead for gamma rays, and the favorable property of lithium with respect to secondary gamma rays. The glass formation range in this system was fairly wide and twelve samples were prepared in this region. Measurements on thermal expansion coefficients, incipient softening points, and densities gave values of $6 \sim 15 \times 10^{-6}$ cm/cm°C, 300 ~ 500°C, and 2 ~ 7.5 g/cm^3, respectively. Differential thermal analysis indicated very strong exothermal peaks owing to crystallization of glasses. This was confirmed by x-ray diffraction. Glasses of this system were confirmed to have considerable radiation shielding ability for gamma rays and neutrons. A defect of glasses in this system is low chemical durability; therefore improvement by addition of a fourth component or surface coating is necessary for practical use. (auth)

11806 THE INFLUENCE OF ^{60}Co GAMMA RADIATION ON THE POTATO STARCH INHIBITING EFFECTS IN LEAD CORROSION IN SOFT WATER. I. N. Putilova, K. A. Korotchenko, and L. F. Gorin (Moscow Technological Inst. of the Food Industry). Zh. Prikl. Khim., 37: 2612-15 (Dec. 1964). (In Russian)

It is shown that potato starch irradiated with large γ doses has a strong inhibiting effect on lead corrosion. Potato starch irradiated with 20 million R doses exhibited the best inhibiting properties (at 0.1% concentration protective effects were equal to 94.5%) chromatographic analysis of corrosion products covering the specimens and in the potato starch solutions showed that they contained phosphorous and low-molecular starch fractions. (R.V.J.)

11807 RADIATION DAMAGE IN NON-FISSIONABLE METALS. D. K. Holmes (Oak Ridge National Lab., Tenn.). p.145-239 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Studies of radiation damage in metals by studying vacancies and interstitials, their production, their energies of motion, their tendencies toward clustering, and their effects on physical properties are discussed. The rate of introduction of damage is considered. The transfer of kinetic energy to lattice ions, threshold energy and cross sections for displacement, radiation annealing, sizes of damaged regions, and damage rates on various metals are discussed. Stages in annealing of radiation damage are described. Recovery following electron, deuteron, and fast neutron bombardments is considered. Radiation effects on mechanical properties are described. Direct observation of radiation damage is discussed. (113 references). (M.C.G.)

11808 RADIATION DAMAGE IN ALLOYS. S. F. Pugh (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.261-95 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Differences between radiation damage in pure metals and in alloys are discussed. Two types of radiation are considered: that, which produces primary knocked-on atoms with energies not greatly exceeding that required for displacement of each primary from its site on the crystal lattice, and that, which produces high-energy primaries typically with energies of about 100 kev. Structural changes caused in alloys by irradiation, solute atom-point defect interactions, mechanical property changes in irradiated alloys, and thermal spikes are discussed. (112 references.) (M.C.G.)

11809 RADIATION-EMBRITTLEMENT OF METALS AND ALLOYS. M. S. Wechsler (Oak Ridge National Lab., Tenn.). p.296-345 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Enhancement of low-temperature brittleness by neutron irradiation is reviewed. Tests developed to assess susceptibility to brittle fracture, pertinent metallurgical variables, and the theoretical ideas used to interpret the results are discussed. The way in which radiation affects the ability of materials to remain intact under the application of stresses was also considered. Tensile tests on irradiated fcc, hcp, and bcc metals are reviewed. It was concluded that the principal consequences of irradiation are to increase the yield stress and the temperature dependence of the yield stress and to decrease the rate of work-hardening and the uniform and fracture strains. Radiation effects on impact properties and stress rupture properties are also reviewed. (169 references). (M.C.G.)

11810 IRRADIATION EFFECTS IN METALS AND FISSIONABLE ALLOYS. Y. Quéré (Centre d'Etudes Nucléaires, Fontenay-aux-Roses, France). p.346-61 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Some effects of fission fragments on uranium and its alloys are described. The irradiation of plutonium by its own alpha emission is considered. A secondary radiation effect, swelling, which is of interest in the operation of reactors is discussed. (M.C.G.)

11811 RADIATION EFFECTS AND DEFECT STRUCTURES IN DIAMOND STRUCTURE SEMICONDUCTORS. J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). p.421-70 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Radiation damage and defects in semiconductors are discussed in terms of their influence on physical behavior, energy of motion of defects, solid-state chemical interactions between defects and other imperfections, and the electronic structure of defects and defect complexes. Defects produced by means other than irradiation, various radiation sources employed for introducing lattice damage, characteristic differences in defect configurations, structure sensitive properties as indices of the extent of lattice damage, and alterations in defect configurations during annealing are considered. Defects caused by fast neutrons, fast charged particles, thermal neutrons, fast electrons, and gamma rays are described. Defects in silicon and germanium are discussed and the data reviewed. (84 references). (M.C.G.)

11812 THE DIRECT OBSERVATION OF LATTICE DEFECTS BY MEANS OF ELECTRON MICROSCOPY. S. Amelinckx (S.C.K., Mol, Belg.). p.682-754 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The various experimental techniques used to prepare specimens and to introduce defect clusters for direct observation of lattice defects by means of electron microscopy are discussed. The interpretation of micrographs is illustrated by specific examples, and results obtained by this technique are reviewed. Radioinduced defects are described and examples shown. Methods for distinguishing vacancies from interstitial loops are discussed. Dislocations resulting from the clustering of point defects are described. Studies of radioinduced defects in Cu, Al, Pt, Au, Ni, stainless steel, Cd, Zn, Fe, Mo, alkali metal halides, PbI_2, MgO, graphite, and U are reviewed. A method for obtaining activation energies from observations on dislocation loops, measurements of electric resistivity due to defects, radioinduced increases in critical shear stress, and analyses of fission tracks are discussed. (144 references). (M.C.G.)

11813 THE THERMAL DECOMPOSITION OF IRRADIATED SOLIDS. E. G. Prout (Rhodes Univ., Grahamstown, South Africa). p.25-9 of "National Conference on Nuclear Energy; Application of Isotopes and Radiation." Pelindaba, South Africa, Atomic Energy Board, 1963.

Results on the effects of energetic radiation on the thermal decomposition of permanganates, silver oxide, and mercuric and lead oxalates are summarized. (auth)

11814 THE EFFECT OF NUCLEAR RADIATIONS AND PLASTIC DEFORMATION ON THE INTERNAL FRICTION OF ZIRCONIUM. P. L. Gruzin and A. N. Semenikhin.

p.236-42 of "Relaksatsionnye Yavleniya v Metallakh i Splavakh." Moscow, Metallurgizdat, 1963.

The effect of plastic deformation, annealing, and neutron and gamma-ray radiation on the internal friction and modulus of elasticity of polycrystalline Zr (99.8%) was investigated. Measurements were made by the high frequency method according to the damping of free bending vibrations and the resonant frequency. On the internal friction-temperature curve a wide peak is observed, the maximum of which corresponds to −60°C, with an increase of the level of deformation the peak height increases, for which it is specially rapid for small deformations (up to 1%). For a 20% deformation the peak height is less than for a 1% deformation. After annealing for 4 hours at temperatures greater than 150°C a decrease of the height of the peak of internal friction is observed. The energy for the low temperature peak of internal friction is 3,000 cal/mole. Radiation with a dose of 3×10^6 fast neutrons results in a decrease of the height of the low temperature internal friction peak, and in the appearance of a small sharp peak of internal friction at + 7°C. The possible mechanism of the observed effects is discussed. (auth)

11815 SELECTED ASPECTS OF THE THEORY OF DISPLACEMENTS IN CRYSTALLINE SOLIDS. H. Shulman (Martin Co., Baltimore). 15p. (CONF-617-10)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

Three aspects of the basic mechanisms responsible for permanent damage to crystalline solids are examined. First, it is shown that the use of the "good-as-new" hypothesis, which predicts that the macroscopic primary displacement cross-section is independent of crystalline structure, is not justified in several important cases. Chief among these instances is the irradiation of ordered solids by fast neutrons at temperatures near absolute zero. Second, an argument is presented which predicts that the displacement threshold energy (E_d) depends upon the nature of the elementary interaction involved in the scattering process. Thus, there is reason to believe that calculations of displacement damage which are based on thresholds observed in electron irradiation experiments are usually incorrect. Third, a relationship is developed that gives the number of secondary displacements which result from a primary knock-on having kinetic energy E. The relationship is in terms of the displacement threshold energy, E_d, and the limiting energy for ionization I_c. The expression is $\nu(E) = E/2E_d \exp(-3/4I_c (E-2E_d))$, $(E < I_c)$, and differs from the formula based on the simple hard sphere assumption ($\nu(E) = E/2E_d$) by the exponential correction factor. This factor makes a difference of approximately one-half as E approaches I_c. (auth)

METEOROLOGY

11816 (COO-1370-1) RAIN SCAVENGING STUDIES—DATA COLLECTION AND SYNTHESIS. Final Report. A. Nelson Dingle and Donald F. Gatz (Michigan. Univ., Ann Arbor. Coll. of Engineering). Dec. 1964. Contract AT(11-1)-1370. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

During the month of May, 1964, field data on rain-producing weather systems, and samples of rain suitable for radiochemical and palynological analyses were collected at Chickasha, Oklahoma. Raindrop-size data were recorded at ground level by means of the photoelectric raindrop-size spectrometer. In addition, a tipping-bucket rain gage was used to obtain detailed information on the rainfall intensity variations, and a weighing rain gage of 10 times standard collecting area was used to obtain total rainfall records. Samples of rain were collected by means of 3 fiberglass funnels specially fabricated for the experiment, each having a collecting area of 2.5 m^2. Wind data and measurements of the amount of airborne pollens were also taken. In all, 106 samples of rain were collected for analysis. (auth)

11817 A METEOROLOGICAL STUDY OF DRY-FALLOUT OF RADIOACTIVE DEBRIS. Heinz H. Lettau and Katharina Lettau. Arch. Meteorol., Geophys. Bioklimatol., Ser. A, 14: 218-32(1964).

A general expression is derived for the intensity of dry-fallout based on time variations of beta-activity in surface air, due to worldwide tropospheric distribution of debris from nuclear testings. Model assumptions are outlined for the consideration of large-scale effects of horizontal divergence of air flow and small-scale effects of eddy diffusion. The parameterization is based on the concept of geostrophic drag coefficients and atmospheric boundary-layer theory. The model is completed by a 2-parameter representation of tropospheric profiles of beta activity. Case studies of dry-fallout in 1962 and 1963 at three stations of the United States Public Health Service (USPHS) network are discussed. Dry-fallout rates per day are found to be approximately 10% of average wet-fallout rates of the same period. The average residence time of debris in the troposphere is estimated to be about 65 days if dry-fallout would be the only cleansing process. (auth)

11818 EFFECTS OF METEOROLOGICAL AND ENGINEERING FACTORS ON STACK PLUME RISE. Harry Moses, Gordon H. Strom, and James E. Carson. Nucl. Safety, 6: No. 1, 1–19(1964).

Two empirical formulas, those of Davidson-Bryant and of Holland, and the semitheoretical formula of Bosanquel, for stack plume rise are discussed. Critical examination indicated that for large stacks with appreciable buoyancy, Holland's formula may be used with a Stümke correction factor of about 3. For smaller stack with little buoyancy, a Stümke factor of about 2 may be used. The effect of stability on plume rise was taken into account by adding 10 to 20% of the computed value under lapse conditions and substracting the same amount under stable stratifications. It was found that terrain effects, such as nearby buildings, hills, valleys, and forested areas, must be taken into account. It was also found that meteorological conditions may materially affect plume rise. For example, under sunny conditions with winds of 2 mph or less, intermittent gusts sometimes brought the effluent to the ground within one or two stack heights. Moderate to heavy rain in association with gusty thunderstorm winds produced wide deviations from expected results. Practical considerations for minimizing ground-level concentrations are discussed. (47 references) (M.C.G.)

11819 NOTE ON CALCULATION OF CONCENTRATIONS IN INVERSION CONDITIONS. Remo Galvagni. Riv. Ing. Nucl., 2: 494-7(July-Aug. 1964). (In Italian)

The micrometeorological condition in which a zone in an unstable and dispersing condition is found between a stratum and the ground and the calculation of concentrations in such cases are described. (J.S.R.)

11820 METEOROLOGICAL ASPECTS OF SAMPLING OF AIRBORNE ARTIFICIAL RADIOACTIVITY OVER CANADA. E. R. Walker (Suffield Experimental Station, Can.). 21p. (CONF-640606-9)

From American Physical Society Summer Meeting, Denver.

Meterorological aspects of sampling airborne artificial radioactivity are presented. The main features of the patterns presented in the figures can be explained if the downward motion mechanism is considered the important agent. The Canadian data suggest that dry deposit is normally only a small fraction of deposit in precipitation. (auth)

PHYSICS

General

Refer also to abstract 11655.

11821 (AD-609106) THE INFLUENCE OF VISCOSITY ON SHOCK WAVES STRUCTURED BY RADIATION. Ira M. Cohen and Joseph H. Clarke (Brown Univ., Providence). Oct. 1964. Contract Nonr (562)35. 18p. $1.00(OTS).

The structure of normal shock waves with radiation, viscosity, and thermal conductivity is treated in the physically relevant limit of large radiation absorption length (or photon mean free path) compared to molecular transport length (or molecular mean free path). If radiation is not too intense or the shock too weak, then a viscous, conducting shock is found embedded in a radiation-structured inviscid shock. Under very general conditions, this viscous "shock within a shock" has precisely the same structure as a classical (radiationless) viscous, conducting shock when reinterpreted as to initial and final states, to lowest order in an expansion based on the ratio of the two transport lengths. This lowest order solution is no longer trivial when the optically thin region considered is embedded in a much thicker region. The next order corresponds to the usual optically thin case but the well known formula (accounting for emission but not absorption by the gas) does not apply; the divergence of the radiation flux is actually given by the emission minus absorption of the radiation from the outer region. Since the relative importance of these two effects changes markedly through the inner viscous shock, the usual formula is meaningless. (auth)

11822 (AFCRL-63-343) A MICROWAVE INVESTIGATION OF SELF-QUENCHING CYLINDRICAL DISCHARGES AT LOW PRESSURES. Scientific Report No. 3. Paul R. Caron and Ralph D. Kodis (Brown Univ., Providence). June 1963. Contract AF19(628)-2498. 49p. (AD-422954). $6.60(OTS).

The results of a theoretical and experimental investigation of self-quenching cylindrical discharges at low pressures in nitrogen and oxygen are presented. The quenching theory is based on the electric field dependence of the first Townsend coefficient and leads to an integro-differential equation of the Volterra type whose solution gives the time variation of the frequency shift of a microwave cavity housing the discharge. The measurements were carried out in a TE011 mode cavity; and the advantages of this mode are discussed. Experimental values of cavity frequency shift during the quenching period are obtained and are compared with theoretical results. Formulas are derived for the electron density and percentage ionization during the quenching period of the discharge. The percentage ionization is shown to have two possible values depending on whether ions or electrons are considered. The concept of percentage ionization as a localized quantity is discussed as it applies to the experiment and an average percentage ionization is defined and computed. (auth)

11823 (ARL-64-49(Pt.II)) BASIC RESEARCH ON GAS FLOWS THROUGH ELECTRIC ARCS — THE RADIATING ARC COLUMN. G. L. Mariotte, R. L. Harder, and R. W. Prichard (Electro-Optical Systems, Inc., Pasadena, Calif.). June 3, 1964. Contract AF33(657)-7940. 65p. OTS.

Simple analytic expressions are derived for describing the radiation from an arc confined in a cylindrical constrictor and operating in the general gas-heating or inlet regime. These expressions were obtained by postulating linear relations among the plasma properties σ, u, and ϕ, the electric conductivity, the power radiated per unit volume, and the thermal conductivity integral $\int_0^T \mathrm{Kdt}$, respectively. For initial comparisons, radiation from fully developed arcs in argon and nitrogen was measured as a function of the arc current and the gas pressure in the confining cylinder. These measurements are compared to the appropriate limit in the analytical predictions and the correlation is found to be good, except for the electric field dependence upon current. It was found possible to improve the correlation by modifying the results of the analysis to include, in an approximate manner, the nonlinear relations that actually exist among the properties of the plasma. Similarity parameters, which are inferred from the analysis and approximately derived from the basic equations, are applied successfully to the measurements with argon and nitrogen and to extensive calculations with nitrogen. (auth)

11824 (ARL-64-216) EXPERIMENTAL AND ANALYTICAL STUDY OF THE FUNDAMENTAL INTERACTION AND ENERGY EXCHANGE PROCESSES BETWEEN ELECTRIC ARC DISCHARGES AND CROSS-FLOW FIELDS OF PRE-IONIZED GASES WITH AND WITHOUT THE PRESENCE OF TRANSVERSE MAGNETIC FIELDS. A. C. Malliaris (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.). Dec. 1964. Contract AF33(657)-11310. 114p. (AD-610031). $4.00(OTS).

An experimental and analytical study is conducted of an electrical discharge interacting with a transverse flow of pre-ionized gas in the presence of an applied magnetic field. The experimental work includes high-speed photography and measurements of electrical characteristics, heat transfer to the electrodes, as well as radiation emitted by the discharge. A wide variety of data are presented in graphs and tables. The data are correlated in terms of an approximate theory, which is developed. The comparison of the experiment with the theory is partially satisfactory. Some conclusions of practical interest are: the electrical discharge under consideration has arc-like characteristics. The column occupies a small fraction of the cross sectional area in the flow. The fraction of the input power used for acceleration is small. The predominant mode of energy transport from the discharge is convection. Conduction and radiation are negligible. The input power increases in the presence of a magnetic field but the electrical conductivity is independent of the magnetic field up to 5000 gauss. (auth)

11825 (CAL-RM-1863-E) ION GENERATION BY LASER-SURFACE INTERACTION. Final Report No. RM-1863-E-1. F. A. Giori and A. S. Gilmour, Jr. (Cornell Aeronautical Lab., Inc., Buffalo). May 1964. 30p.

The generation of large quantities of ions (over 1 ampere) and electrons (over 100 amperes) by the illumination of the end of a 0.020 inch-diameter tungsten wire by a pulsed ruby laser are reported. It is shown, on the basis of the vapor pressure of the tungsten (about one atmosphere) and the thermionic emission rate (over 200,000 amperes/cm^2) that the effective temperature of the surface was about 5800°K. The ionization of the tungsten vapor was over 99 per cent complete as measured with a quadrupole mass spectrometer. Singly charged, single-atom ions only were detected by the spectrometer. The average energy of the ions was found to be 15 ev under a wide range of conditions and the energy required per ionization was as low as 4000 ev. (auth)

11826 (KFKI-64-2) TERMODINAMIKAI GREEN-FÜGGVÉNYEK ALKALMAZÁSA A STATISZTIKUS MECHANIKÁBAN. (Thermodynamic Green Function Applied to Statistical Mechanics). Hargitai Csaba and Zawadowski Alfred (Magyar Tudományos Akadémia Központi Fizikai Kutató Intézete, Budapest). 1964. 217p. Dep.(mn).

Use of the Green functions presents many advantages; however, the statistical mechanics of interacting particles is not yet solved, and each single physical problem requires the development of a specific approximation method. The Green functions may be applied not only to systems in thermodynamic equilibrium but also to slightly perturbed, irreversible processes, such as electrical conductivity in

a weak electric field. The method may also be used for analyzing transport phenomena when short relaxation times or strong magnetic fields make it impossible to employ approximations based on the classical transport equations. The report was used as the text for a seminar on the basic concepts of statistical mechanics. (TTT)

11827 (LGI-64/4) DIFFUSION OF MAGNETIC FIELDS IN MOVING CONDUCTORS. G. Lehner (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Feb. 1964. 34p. Dep.(mn).

The so-called "hydromagnet," a device in which a radial flow of a conducting liquid produces an amplification of a magnetic field, is discussed. The flow is assumed to be incompressible. The compression of a magnetic field by the motion of an incompressible liner is studied. For simplicity plane geometry is considered only. The liner moves with a constant velocity ϑ towards a wall of infinite conductivity, while the conductivity of the liner is finite and constant. The compressed field can be represented by an integral equation, which is solved numerically. The maximum field achieved as the volume between liner and wall approaches zero and can be evaluated exactly. (auth)

11828 (NP-14645) HOT ELECTRON IN A STRONG MAGNETIC FIELD. Jiro Yamashita (Tokyo Univ. Inst. for Solid State Physics). Sept. 1964. 40p. Dep.(mn).

A theory of a hot electron in a strong magnetic field is developed. A density-matrix equation is solved in the quantum limit both for a semiconductor with a simple band structure and for a semi-metal in which the same number of electrons and holes coexist. As for the phonon distribution two cases are considered; phonons in thermal equilibrium; and phonon-drag effect. (auth)

11829 (NP-14674) STRONG IONIZING SHOCK WAVES. Report No. 15. Robert A. Gross (Columbia Univ., New York. School of Engineering and Applied Science). Oct. 1964. 64p.

Electromagnetically driven shock waves in hydrogen are theoretically studied for speeds up to relativistic conditions. In the progression from weak to relativistic shock speeds, various physical phenomena affect the shock wave. Dissociation, ionization, and the presence of an upstream electric field cause several important effects for slow (sub Alfvenic speed) normal ionizing shock waves. Switch-on shock behavior is extended to slow ionizing waves. The effect of radiation is investigated for both the optically thick and thin cases. Relativistic shock jump equations are solved for wave speeds approaching the speed of light. Thermonuclear shock solutions are examined. The shock jump equations and the shock tube problem are solved numerically. Wave stability is reviewed. Some experimental results are discussed. (auth)

11830 (NYO-1480-7) ASYMPTOTIC EQUIVALENCE OF THE NAVIER-STOKES AND NONLINEAR BOLTZMANN EQUATIONS. Harold Grad (New York Univ., New York. Courant Inst. of Mathematical Sciences). Sept. 30, 1964. Contract AT(30-1)-1480. 56p. (MF-41; CONF-640602-1). Dep.(mn); $3.00(cy), 1(mn) OTS.

From American Mathematical Society Symposium on Application of Partial Differential Equations in Mathematical Physics, New York.

The theory of the linear Boltzmann equation is extended to somewhat nonlinear problems. For sufficiently small initial data, solutions are shown to exist for macroscopically long times. If the mean free path is small the nonlinear solution is particularly well approximated by the linear solution, and it is also approximated by the macroscopic Navier-Stokes solution of an equivalent probelem. (auth)

11831 (PAN-538/XVIII) SPEKTRALNE POMIARY TEMPERATURY W PLAZMOTRONIE. (Spectral Measurements of Temperature in Plasmatron). Sz. Suckewer (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1964. 24p. Dep.

The temperature of argon plasma has been measured in two plasmatron types and also on the basis of changes in the intensity of continuous spectrum in quartz ultraviolet. In the method are utilized the copper impurity lines, for which the coefficients were calculated. The measurements were made for plasmatrons operating in the external and internal arc systems, as a function of supply power and argon mass flow. It was shown that the principal cause of temperature changes in the plasmatron of stable nozzle cross section and of laminar flow of operating gas (argon), lies in the change of power; temperatures for close values of supply power in the internal and external arcs are close. Measurements made for the same region of plasma stream, using the method mentioned above, yielded results with good agreement. Densities of electrons and argon atoms were also calculated. (auth)

11832 (RADC-TDR-64-352) PROPAGATION OF NONLINEAR HAHN-RAMO WAVES ALONG AN ANNULAR ELECTRON CURRENT SHEATH. Research Report No. 40. Technical Note No. 2. S. Olving and O. Nilsson (Chalmers Tekniska Hogskola, Goteborg. Forskningslaboratorium for Elektronik). Nov. 1, 1963. Contract AF61(052)-594. 42p. (AD-603572). $2.00(OTS).

The report deals with an analytical nonlinear theory of space charge wave propagation along an annular current sheath in a conducting tunnel. The effect of nonlinearities on fundamental frequency amplitude saturation, the behavior of harmonic frequency waves, and the distortion of waveforms is considered. (auth)

11833 BREAKDOWN IN HIGH FREQUENCY ELECTRODELESS DISCHARGE AT LOW PRESSURE IN THE PRESENCE OF A STEADY TRANSVERSE MAGNETIC FIELD. S. Deb and S. N. Goswami (Jadavpur Univ., Calcutta). Brit. J. Appl. Phys., 15: 1501-9(Dec. 1964).

A theoretical investigation was made of the problem of electric breakdown in a high frequency electrodeless discharge at low pressure in the presence of a steady transverse magnetic field following the method of von Engel et al., for similar discharge without such a field. Curves giving the breakdown field as a function of wavelength with α, the ratio of the cyclotron frequency to the frequency of the applied field, were drawn. It is shown that with increase in α the breakdown field tends to increase and the main region of the curve displaced towards longer wavelengths. The increase in breakdown field with a given change in α is found to be more pronounced with the higher order modes of discharge. The effect of angle of arrival at the end walls of the charged carriers on the breakdown mechanism was also considered. Results indicate that the effect should counteract appreciably the aforesaid tendency of the breakdown field to increase in the presence of a magnetic field. The so-called cut-off values of wavelengths were also computed. It is shown that the cut-off value increases with increase in α, and in contrast to the situation in the absence of a magnetic field, might define either a long or short wavelength limit of discharge depending upon the value of α. (auth)

11834 ON THE MECHANISM OF THE PENNING DISCHARGE. E. H. Hirsch (Weapons Research Establishment, Salisbury, Australia). Brit. J. Appl. Phys., 15: 1535-43(Dec. 1964).

Experiments confirm that the maintenance of a Penning discharge in its normal mode is governed by a thin electron sheath, situated close to the anode. The observations indicate that electron transport to the anode occurs by a mechanism not involving molecular collisions. Electrons in the discharge undergo anomalous energy scattering, and the resulting excess energy electrons can readily cross the magnetic lines of force. This suggests cross-field diffusion through interaction with space charge oscillations, and the same mechanism may explain anomalous diffusion generally in magnetically confined discharges. The discharge structure is investigated, and mode changes are shown to be associated with the appearance of excess energy electrons in certain discharge regions. (auth)

11835 CONTRIBUTION TO THE STUDY OF FLAMES. Jean Debiesse and Siegfried Klein (C.E.N.S., Gif-sur-

Yvette, France). Compt. Rend., 259: 3470-3(Nov. 16, 1964). (In French)

A difference of potential of the order of a volt was obtained between two electrodes at different temperatures plunged into a flame. This difference of potential was largely modulated by the injection of electronegative gas on one or the other of the electrodes maintained at constant temperatures. (tr-auth)

11836 THE STRUCTURE OF SHOCKS IN AN IONIZED GAS PROVIDED WITH AN ANISOTROPIC VISCOSITY. Thérèse Lévy (Faculte des Sciences, Paris). Compt. Rend., 259: 3681-4(Nov. 23, 1964). (In French)

In a completely ionized gas, the presence of a magnetic field has the effect of destroying the proportionality of the thermal flux and the temperature gradient as well as the proportionality of the tensor deviation of pressures and the symmetric tensor deviator constructed from the gradient of the mean velocity. The effect of this anisotropy on the shock wave structure was studied. (tr-auth)

11837 STRUCTURAL CHARACTERISTICS OF THE NEGATIVE-ION CONTENT IN A STRIATED GLOW DISCHARGE OF OXYGEN. Helmut Drost, Ulrich Timm, Gerhard Lindemann, and Herbert Pupke. Exptl. Tech. Physik, 12: 269-73(1964). (In German)

The pattern of the negative ion current exhausted anodically in dependence on the discharge current or pressure showed periodicities that can be related to a structural character of the negative ion content within the glowing column strata. Visual observations, simultaneously carried out, indicated that this ion structure was often not in correlation with the optical excitation behaviors in the strata. The ion periodicity was discussed in connection with the concept of the double layer, the various electron energies in the plasma, and the velocity-dependent formation for 0^- and 0_2^-. At higher discharge currents or at lower discharge pressures, the structure character of the ion content disappears. (tr-auth)

11838 INVESTIGATIONS ON A PLASMA SOURCE FOR NEGATIVE IONS. III. PROBE MEASUREMENTS IN THE PLASMA BEFORE THE INLET ANODE. Helmut Drost, Gerhard Lindemann, Ulrich Timm, and Herbert Pupke. Exptl. Tech. Physik, 12: 274-80(1964). (In German)

The plasma source described previously was investigated in greater detail. The question of increasing the ion yield after introduction of an anodic auxiliary electrode and the formation of a discharge extension was made clearer by probe measurements in the plasma of the extension. It was shown that the formation of an anodic extension is connected always with electron cooling, i.e., with a decrease of T_e and an increase of the density N_e. Only the cooling effect was regarded as the origin of the yield increase, however. The results find a qualitative significance by reference to the small probability of ion perturbation in collision processes, especially at low T_e. (tr-auth)

11839 PARTICLE DISTRIBUTION IN A CENTRALLY-SYMMETRIC FIELD IN THE PRESENCE OF AN INCOMING STREAM. PART I. A. M. Moskalenko (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 203-14(1964). Translated from Geomagnetizm i Aeronomiya, 4: 260-74(1964).

Consideration is given to the distribution of particles in a rarefied gas in a Coulomb attraction field, given the presence of an incoming stream. General expressions are derived for the concentration and flux of particles in infinite motion (i.e., open orbits with respect to the attraction region). Infinite particle concentration and flux are calculated for cases when the velocity of the incoming stream is much less and much greater than the particle thermal velocity. Particle absorption on the surface of the body is taken into consideration. (auth)

11840 PHONON EMISSION IN PIEZOELECTRIC SOLIDS. J. C. Ashley (Marshall Space Flight Center, Huntsville, Ala.). J. Appl. Phys., 36: 528-33(Feb. 1965).

The spontaneous Cherenkov-like emission of phonons is calculated for a charged particle moving in an arbitrary direction with a supersonic velocity through a solid. The coupling of the particle to the lattice is through the electric fields of piezoelectric origin; first-order perturbation theory is used to calculate the rate of energy loss by the particle to the phonon field. A special case is considered for particle motion along the axis of hexagonal symmetry for a class 26 crystal (such as CdS) using a quasi-isotropic model to describe the tensor properties of the solid. Comparison of the induced emission and absorption of phonons with the spontaneous emission indicates that the Cherenkov-like emission is negligible under most conditions. (auth)

11841 VELOCITY DISTRIBUTIONS IN ELECTRON BEAMS. Robert L. Gunshor (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 36: 654(Feb. 1965).

An experimental arrangement for measuring velocity distributions in electron beams is described. A retarding electrode system is used which enables the beam retarding electrode to be separate from the beam collecting electrode. A small sinusoidal voltage at 1 kc is connected in series with the retarding electrode. This a-c signal is superimposed on the d-c retarding potential. The axial velocity distribution is then proportional to the 1 kc component of the collector current. (C.E.S.)

11842 CIRCULATION IN RELATIVISTIC CONTINUUM MECHANICS. Dominic G. B. Edelen (RAND Corp., Santa Monica, Calif.). J. Math. Anal. Appls., 9: 331-5(Dec. 1964).

A discussion is given of a class of integrals formed from quantities that describe the behavior of material regions of an Einstein-Riemann space. The generalized stress tensor, the rotation tensor, and the Fermi rotation tensor are defined. Conditions on the stress tensor are derived for a functional measuring the circulation of a C^1 vector field on the material region to be admitted as a constant of a defined motion. (M.J.T.)

11843 HIGH MAGNETIC FIELDS BY THE USE OF A MERCURY COIL. E. Quercigh (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nucl. Instr. Methods, 31: 279-84(Dec. 11, 1964).

A method of producing high pulsed magnetic fields by the use of an exploding mercury coil is described. The coil can be reconstructed in a few seconds after each discharge. The results of tests on a single turn model for fields to 340 kilogauss are discussed. (auth)

11844 PARTITION EFFECTS IN TRANSVERSE ELECTRON-BEAM WAVES. P. A. H. Hart. Thesis, Eindhoven, Netherlands, Technische Hochschule, 1964. Philips Res. Rept., Suppl., No. 4, 59p.(1964).

Four independent transverse waves are possible on a beam focused by an axial magnetic field. A theory is presented describing the attenuation of the transverse modulation of the beam and the noise generated if part of the beam is intercepted, scattered, or if there is spread in axial electron velocity. To represent the beam having a finite cross section the disk model was used. The generation of noise is shown to be proportional to the attenuation of the original waves and to the beam's internal temperature. Moreover the noise waves generated appear to be partly correlated. The theory was verified experimentally in case of interception and scattering for the fast cyclotron wave and both the positive- and negative-energy synchronous waves. Measurements with the fast cyclotron wave by means of a modified Adler-Wade tube are in good agreement with the theory. The theory also predicts satisfactorily the attenuation of both synchronous waves and the noise generated in the negative-energy synchronous mode. However, the noise generated in the positive-energy synchronous mode was found to be approximately twice as large as was expected. This discrepancy could be accounted for by an extension of the theory so as to include the correlation in the internal electron motion. The syn-

chronous-wave measurements were performed by means of a tube with Cuccia input and output couplers and two quadrupole structures in between, converting the fast cyclotron wave into a synchronous wave and vice versa. (auth)

11845 LOWER BOUNDS FOR THE HELMHOLTZ FUNCTION. Sidney Golden (Brandeis Univ., Waltham, Mass.). Phys. Rev., 137: B1127-(Feb. 22, 1965).

A mathematical theorem is established for traces of products of bounded Hermitian and definite operators, a and b: $Tr(ab)^{2p+1} \leq Tr(a^2b^2)^{2p}$ for p a non-negative integer. This theorem is applied to the equilibrium partition function by exploiting an infinite-product representation of the exponential function of the sum of two operators. As a result, a set of inequalities is established which yields a set of upper bounds for the partition function. This result is invariant to the particle statistics of the system. A general argument yields the result that the classical Helmholtz free-energy function serves as a lower bound to the corresponding quantum result. (auth)

11846 THE STATE OF THE PHYSICS OF ELEMENTARY PARTICLES AND HIGH ENERGY NUCLEAR PHYSICS IN POLAND. Marian Miesowicz (Inst. of Nuclear Research, Krakow and Academy of Gornicz-Hutnicz, Poland). Postepy Fiz., 15: 367-73(1964). (In Polish)

Activities in high-energy physics in Poland are summarized, ranging from cosmic-ray work to accelerator studies of interactions at 1 to 30 Bev. Research on cosmic particles and electromagnetic radiation, cosmic showers, and hyperfragment physics is covered, together with the experimental facilities and techniques. (D.C.W.)

11847 STATIONARY ROTATION OF A RAREFIED GRAVITATIONAL GAS MASS IN MAGNETIC FIELD. M. K. Zhekamukhov. Vestn. Mosk. Univ., Ser. III, Fix. Astron., No. 4, 23-8(July-Aug. 1964). (In Russian)

Rotation of rarefied gravitational gas mass in a magnetic field was investigated without taking into account the pressure forces. Magnetohydrodynamic equations were derived for three cases in which the magnetic field vectors in a cylindrical coordinate system had the appearance of $\vec{H}(H_r,H_\varphi,0)$, $\vec{H}(0,0,H_z)$, and $\vec{H}(0,H_\varphi,0)$. Several events of rotation were analyzed considering the pressure force. (tr-auth)

11848 A TARGET CHAMBER USED FOR ENERGY CALIBRATION. Guang-chang Xia. Wu Li Hsueh Pao, 20: 1056-7(Oct. 1964). (In Chinese)

As a result of the contamination of the target by the oil vapor from the vacuum system, the energy calibaration method based on the (p,γ) resonance peak principle usually includes an error which depends on the energy loss by the particle passing through the layer of contaminant covering the target. In order to prevent this, a special target chamber was designed. The system also includes a cold trap and a heating system for the target. The liquid nitrogen cold trap surrounds the target while the heating device is able to keep it at a constant temperature of 200°C. After test runs lasting up to 80 hours, no contamination could be detected on the target when the new system was used. (TTT)

11849 THERMOMAGNETIC WAVES IN A SOLID BODY. L. E. Gurevich and B. L. Gelmont (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 1806-13(Nov. 1964). (In Russian)

It is demonstrated that in a number of metals and semimetals with a temperature gradient ∇T, waves of a new type may exist at sufficiently low temperatures. The possibility of existence of such waves was previously predicted for a plasma and designated as thermomagnetic waves. It is found that in the presence of a magnetic field the waves become unstable. In a weak magnetic field the instability is of a convective nature; in a strong field it is absolute. The features of the waves and their instability in conductors with carriers of one or both signs are considered. (auth)

11850 MAGNETIC SUSCEPTIBILITY IN STRONG MAGNETIC FIELDS. M. Ya. Azbel and E. G. Skrotskaya (Inst. of Physico-Technical and Radio-Technical Measurements, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1958-65(Nov. 1964). (In Russian)

The conductivity electrons magnetic moment in strong magnetic fields is determined. It is found that the magnetic field strength dependence of the ground state energy and level density can be deduced from an experimental investigation of the magnetic susceptibility for an arbitrary dispersion law. It is shown that for a quadratic dispersion law in strong magnetic fields the magnetic moment (diamagnetic or paramagnetic) approaches saturation. (auth)

11851 TRANSITION PHENOMENA IN RADIO FREQUENCY THREE-LEVEL QUANTUM GENERATORS. A. A. Manenkov, R. M. Martirosian, Yu. P. Pimenov, A. M. Prokhorov, and V. A. Sichugov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2055-63(Dec. 1964). (In Russian)

Experimental and theoretical investigations of the establishment of oscillation amplitude in quantum paramagnetic generators in the radio frequency range are presented. The active substance in the generators employed are ruby or rutile crystals containing Cr^{3+} admixtures. Radiation from the generators was emitted in the 21 and 10 cm wavelength region respectively. On pulsed pumping in the generators a transition process is observed which consists of amplitude damped oscillations and subsequent exponential approach to stationary conditions. A theoretical analysis of the transition processes is carried out on basis of the kinetic equations for a three-level model. A solution of the equations in the linear approximation was obtained in analytical form. Formulas are also derived for the time elapsing between the beginning of pumping and beginning of generation. The theoretical calculations are in good agreement with the experimental data. (auth)

11852 ON THE EFFECT OF SPATIAL DISPERSION ON THE PROPAGATION AND SCATTERING OF WAVES NEAR THE CRITICAL POINT. M. Sh. Giterman and V. M. Kontorovich (Inst. of Physics and Tech. and Radio-Technical Measurements, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 2134-49(Dec. 1964). (In Russian)

Due to high compressibility near the critical state of matter, the nonlocal connection between changes of pressure and changes of density (spatial dispersion) plays an important role. As a result, the velocity of sound depends on the wavelength and correspondingly the nature of scattering and absorption of sound as well as of electromagnetic waves also changes. Characteristics of the average and scattered fields (dispersion and absorption of waves, extinction coefficient of light waves, intensity of the Mandelstam—Brillouin doublet etc.) are determined on basis of the general theory of fluctuations of hydrodynamic quantities as extended to the case of media with space dispersion. These characteristics can be employed in experimental critical transition investigations. (auth)

11853 NEGATIVE ENERGY WAVES IN DISPERSIVE MEDIA. B. B. Kadomtsev, A. B. Mikhailovskii, and A. V. Timofeev. Zh. Eksperim. i Teor. Fiz., 47: 2266-8(Dec. 1964). (In Russian)

It is shown that transparent media may possess anomalous dispersion and in this case the energy of a monochromatic electromagnetic wave may be negative. This means that the energy of a medium with a wave is less than the energy of a medium in the absence of the wave. Negativity of energy leads to a number of peculiar effects in the propagation and interaction of waves. (auth)

11854 ASYMPTOTIC RESOLVING PROPERTIES OF THE CHARACTERISTIC EQUATION FOR THE THEORY OF RADIATION TRANSFER IN STRONGLY ABSORBING MEDIA. M. V. Maslennikov and T. A. Sushkevich. Zh. Vychislitel. Mat. i Mat. Fiz., 4: 23-34(Jan.-Feb. 1964). (In Russian)

An analysis was made of an integral equation M(λ)

$(1+\lambda\mu)\varphi_\lambda(\mu) = g\varphi_\lambda(\mu)$, where μ is an independent variable $\mu\epsilon[-1,1]$, $\varphi_\lambda(\mu)$ is an unknown function, λ is a parameter $\lambda\epsilon(0,1)$, $g\varphi(\mu) = \int_{-1}^{1} g(\mu,\mu')\,\varphi(\mu')\,d(\mu')$ and $g(\mu,\mu')$ is the kernel which must be determined. An attempt was made to resolve the problem of asymptotic behavior of the eigenvalue $M(\lambda)$ and the eigenvalue function $\varphi_\lambda(\mu)$ (with the λ value close to unity) for the theory of radiation transport in a strongly absorbing substance. (R.V.J.)

11855 GROUP THEORY AND SOLID STATE PHYSICS. A SELECTION OF PAPERS. VOL. 1. Paul H. Meijer, ed. International Science Review Series. New York, Gordon and Breach Science Publishers, 1964. 302p.

A collection of papers (16) on the application of group theory to crystal structure and properties and to molecular vibrations is presented. (D.C.W.)

11856 THE EQUILIBRIUM THEORY OF CLASSICAL FLUIDS. A Lecture Note and Reprint Volume. Harry L. Frisch and Joel L. Lebowitz. Frontiers in Physics. New York, W. A. Benjamin, Inc., 1964. 425p. $11.00 (Cloth); $6.55 (paperback).

A collection of papers (28) on general theory, series expansions and integral equations, and phase transitions and critical phenomena is presented. A bibliography with 93 entries of special relevance to the equilibrium theory of classical fluids is also included. (D.C.W.)

11857 ADIABATIC INVARIANT OF THE HARMONIC OSCILLATOR. R. M. Kulsrud (Princeton Univ., N. J.). p.254-9 of "Advanced Plasma Theory." New York, Academic Press, 1964.

The constancy to all orders of the adiabatic invariant of a simple harmonic oscillator with a slowly varying spring constant is established. (D.C.W.)

11858 SOME PROBLEMS IN THE THEORY OF A LOW VOLTAGE RESONANCE ELECTRON DISCHARGE. V. I. Petrunin. p.97-118 of "Elektrofizicheskaya Aparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Standard relations describing resonance electron motion in a plane gap were developed for applications to cavity resonators. Various problems in the theory of multiplication phenomena in cavity resonators are discussed. (R.V.J.)

11859 RADIATION SOURCES. A. Charlesby, ed. A Pergamon Press Book. New York, The Macmillan Company, 1964. 272p.

Eight papers are presented, containing descriptions of various radiation sources used for studies in radiation physics, radiation chemistry, and radiobiology. Separate abstracts were prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 11457, 11590, 11638, 12020, 12021, 12022, 12023, and 12852.

11860 THE LYTTLETON-BONDI UNIVERSE AND CHARGE EQUALITY. V. W. Hughes. p.259-78 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

Theoretical arguments on the electron-proton charge ratio are summarized; and some implications for gravitation, astronomy, and cosmology of a slight departure from equality are discussed, together with the most recent experimental determinations of the charge ratio. (D.C.W.)

11861 GENERAL RESEARCH. INTRINSIC PHOTOEMISSION OF ALKALI HALIDES. S. W. Duckett and P. H. Metzger (Aerospace Corp., El Segundo, Calif.). 25p. (CONF-481-83)

From American Physical Society Annual Meeting, New York, Jan. 1964.

The photoemission from evaporated films of 12 alkali halides was measured in the 10 to 21 ev energy region. In addition, some preliminary optical density values were obtained by measuring the transmission of evaporated layers of these compounds deposited on 450 Å-thick, self-supporting, Al_2O_3 films. The photoemission yield curves show broad structures correlated with the absorption coefficients. In general, the photoemission is a maximum for photons of energies of about 5 ev greater than the forbidden gap energy, E_g, with additional peaks beyond 2 E_g. The correlation of the yield with the absorption coefficient is most pronounced in the alkali fluorides, which have relatively low yields, but is less apparent in the other halides, which have peak values of as much as 0.8 electron/photon. A random walk model of electron scattering is used to estimate the magnitude of the yields and the dependence on the absorption coefficient, with good qualitative agreement with the experimental results, but other processes cannot be ruled out. (auth)

11862 CYCLOTRON RESONANCE AND THE FREE-CARRIER MAGNETO-OPTICAL PROPERTIES OF A SEMICONDUCTOR. N. K. Hindley (Univ. of Illinois, Urbana). 32p. (CONF-543-15)

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

The high frequency conductivity tensor σ_{ij} is calculated for a semiconductor with a quadratic band structure in a magnetic field. The existence of an energy-dependent relaxation time $\tau(E)$ is assumed. For both an isotropic band and a band with a many-valley structure, σ_{ij} can be expressed in terms of three similar functions, σ_A and σ. For an isotropic band, σ_A is the conductivity for a circularly polarized electric field and σ is the conductivity for zero magnetic field. It is shown that these coefficients satisfy certain sum rules. When $\tau \propto E^p$, they are given by tabulated integrals. The results are applied to cyclotron resonance and compared with experimental measurements on n-CdTe. The assumption that $p = 3/2$ (ionized impurity scattering) gives the best agreement with experiment. The free carrier magneto-optical properties can be calculated if σ_{ij} is known, and under low loss conditions the Faraday rotation and ellipticity, and the Voigt effect, may be expressed fairly simply in terms of σ_A and σ. The Faraday rotation in n-Ge is calculated as a function of magnetic field, and the results are compared with experiment. (auth)

11863 A COMPARISON BETWEEN THE ELECTRON-PHONON INTERACTIONS OF TOYA AND BAILYN. P. L. Srivastava (Banaras Hindu Univ., India). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/25, 14p. (CONF-804-16)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The determination of the total matrix element of electron-phonon interaction from the screening of the ionic perturbation in metals was considered. The vibration frequencies for Cu and Na were recalculated using Bailyn's total matrix element and approximating the energy expression by the true energy. The frequency spectra are in better agreement with neutron diffraction results than the spectra obtained by Toya. The specific heats were also calculated in better agreement with experimental results, using the Bailyn formulation. (D.C.W.)

Accelerators

11864 (LNF-63/82) UN DISPOSITIVO PER LA FOCALIZZAZIONE E L'ANALISI MAGNETICA DI PIONI CARICHI FOTOPRODOTTI DALL'ELETTROSINCROTRONE DI FRASCATI. PARTE IIa. DESCRIZIONE DELLE MISURE MAGNETICHE EFFETTUATE SUGLI ELETTROMAGNETI COMPONENTI IL DISPOSITIVO. (An Apparatus for the Focusing and Magnetic Analysis of Charged Photopions from the Frascati Synchrotron. Part IIa. Description of the Magnetic Measurement Made on the Electromagnets Comprising the Apparatus). Note No. 226. G. Sanna (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Dec. 18, 1963. 41p. Dep.(mn).

The simplified model adopted for the field distributions is derived separately for the quadrupole lens and the analyzing magnets. The magnetic measurements made (the methods, evaluation of errors, and results) are

described, and the results obtained are represented graphically. (J.S.R.)

11865 (LNF-64/45) UNA CATENA ELETTRONICA TRANSISTORIZZATA PER ESPERIENZE CON L'ELETTROSINCROTRONE. (A Transistorized Electronic Circuit for Experiments with the Electron Synchrotron). Note No. 257. G. Penso and V. Silvestrini (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 30, 1964. 21p. Dep.(mn).

The transistorized electronics constructed for η experiments at Frascati were described. In addition to descriptions of the individual circuits, practical data on their performance were included. The limiter, coincidence circuits, fast elongator, discriminator, gate trigger, fast amplifier, linear gate, integrator, slow amplifier, and input security circuits were given. (J.S.R.)

11866 (SLAC-32) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, April 1–June 30, 1964. (Stanford Univ., Calif. Stanford Linear Accelerator Center). Oct. 1964. Contracts AT(04-3)-400 and AT(04-3)-515. 107p. Dep.; $2.25(cy), 2(mn) OTS.

The design and development of the two-mile-long Stanford Linear Electron Accelerator are summarized. Information is included on: plant engineering, systems engineering and installations, accelerator physics, instrumentation, heavy electronics, mechanical design and fabrication, klystron studies, operation of the Mark IV prototype, beam switchyard design and development, target area development, and pre-operations research and development. (N.W.R.)

11867 THE TECHNICAL CONSTRUCTION AND THE ELECTRICAL BEHAVIOR OF THE 1.5-Mv STEADY VOLTAGE INSTALLATION IN BERLIN-BUCH. Wolfgang Biener. Exptl. Tech. Physik, 12: 218-30(1964). (In German)

The technical construction of a linear accelerator installation with a 1.5-Mv generator in seven-stage doubler circuit and with two switchless load units was described. The results of the measurements on the operating behavior were reported and evaluated. (tr-auth)

11868 THE DOSIMETRY OF THE HIGH-VOLTAGE X-RAY INSTALLATION OF THE INSTITUT FUR BIOPHYSIK OF THE DADW. Johannes Krumbiegel, Ulrich Proesch, and Rudolf Schneiderreit. Exptl. Tech. Physik, 12: 240-4(1964). (In German)

The dose distribution and dose output of the high voltage x-ray installation under various operating conditions were reported. The measurements were made with three different methods–Fricke dosimetry, glass dosimetry, and scintillation dosimetry. (tr-auth)

11869 DETERMINATION OF THE BREMSSTRAHLUNG SPECTRUM AT THE 1.5-Mv X-RAY TUBE. Rudolf Schneiderreit, Johannes Krumbiegel, and Peter Schwensow. Exptl. Tech. Physik, 12: 247-52(1964). (In German)

The bremsstrahlung spectrum of the 1.5-Mv x-ray tube was calculated with the Silberstein method from the filter curve. Lead was used as the filter material. (tr-auth)

11870 THE GENERATOR ION TUBE. Peter Schwensow. Exptl. Tech. Physik, 12: 254-8(1964). (In German)

The construction and mode of operation of the generator ion tube were described. The first results in its application as a neutron source and in direct nuclear transformation were reported. (tr-auth)

11871 CHARACTERISTICS OF THE SYNCHROTRON LIGHT FROM THE NBS 180-Mev MACHINE. K. Codling and R. P. Madden (National Bureau of Standards, Washington, D. C.). J. Appl. Phys., 36: 380-7(Feb. 1965).

The characteristics of the synchrotron light emitted by electrons in the NBS 180-Mev electron synchrotron were studied in detail. The electron beam cross section was approximately 1 × 2 mm. The angular distribution and polarization properties were determined for the visible radiation; photoelectric techniques resulted in a more critical comparison of the experimental results to the theoretical predictions than heretofore possible. Doubts raised by previous work regarding the symmetry of the radiation with respect to the orbital plane were allayed. Characteristics of the radiation in the extreme ultraviolet are calculated for the NBS machine, and applications of this source for physical experiments are discussed. (auth)

11872 ENERGY BALANCE OF A REFLEX DISCHARGE. R. Basile and J. M. Lagrange (Université de Paris, Orsay, France). Nucl. Instr. Methods, 31: 195-204(Dec. 11, 1964). (In French)

As part of the construction program of a heavy multiply charged ion source for the variable cyclotron being constructed at Orsay, a theoretical study of a reflex ion source was made. The equation of energy balance for the arc discharge is given as a function of its different parameters: gas flow, arc voltage, electron current, and ion current. A determination was also made of β, the energy necessary to create one ion in the plasma. Experimental results confirm β theoretical values. (auth)

11873 ON THE COMPLETE DISTURBANCE OF ELECTRON BEAMS IN A MICROTRON. COMPENSATION OF MAGNETIC INTERFERENCE FIELDS. H. Reich and K. Loens (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instr. Methods, 31: 221-5(Dec. 11, 1964). (In German)

The magnetic disturbance originating from the extractor tube in a microtron acts upon the electron in the last orbits and causes beam losses, which–on big machines–amount to more than half the undisturbed beam current. By means of a grid arrangement of iron rods parallel to the extractor tube the field distortion can be compensated almost completely. Such a grid of rods can generally be used for the screening of disturbing fields, e.g., the end effects of a magnet. The range of influence of the grid arrangement is calculated for a regular grid and studied experimentally for a nonregular grid. Results are given in the form of curves. The application of the grid arrangement to a 5 Mev microtron showed its usefulness. (auth)

11874 PARTICLE TRAJECTORIES IN ACCELERATION TUBES. P. H. Rose (High Voltage Engineering Corp., Burlington, Mass.), A. Galejs, and L. Peck. Nucl. Instr. Methods, 31: 262-8(Dec. 11, 1964).

A method of calculating the exact trajectories of particles through acceleration tubes is described. The method is illustrated by considering a uniform field acceleration tube in detail. It is shown that the electrode thickness is important for small diameter tubes and that spherical aberration in the entrance region must not be neglected. (auth)

11875 A SINGLE CAVITY ACCELERATOR FOR 1 Mev PROTONS. A. A. Glazov, V. A. Kochkin, D. L. Novikov, and L. M. Onischenko (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instr. Methods, 31: 285-92(Dec. 11, 1964).

A 1 Mev proton injector of the ring-shaped phasotron model designed and constructed at the Laboratory of Nuclear Problems at Dubna in 1960-62 is described. Protons are accelerated in the gap of a toroidal cavity excited at the basic frequency of about 60 MHz by a self-excited oscillator. A cold cathode of the Penning discharge type is used as an ion source. Proton current of 10 mamp per 20 μsec pulse is supplied by the injector at the repetition rate of 50 Hz. (auth)

11876 A SIMPLE REMOTELY-CONTROLLED TARGET CHANGER. J. T. Heinrich (Argonne National Lab., Ill.). Nucl. Instr. Methods, 31: 337-8(Dec. 11, 1964).

With the target changer described, any one of eight target foils can be placed in an accelerator beam by remote control. The simple foil-holding frame facilitates inserting different targets into the changer. In addition, the design is compact and easy to construct. (auth)

11877 A COMPACT DUOPLASMATRON ION SOURCE USING A FERRITE PERMANENT MAGNET. H. Tawara, S. Suganomata, and S. Suematsu (Hitachi Ltd., Japan). Nucl. Instr. Methods, 31: 353-4(Dec. 11, 1964).

A compact duoplasmatron ion source using a ferrite permanent magnet was constructed. A plasma arc is constricted by an intermediate electrode and then by a magnetic field. Advantages of using a Ba ferrite permanent magnet to produce the field are considered. Diagrams and descriptions of the duoplasmatron source are given. Factors affecting the mass ratio of ions from the source are discussed. (M.J.T.)

11878 A 250 kv COCKCROFT-WALTON VOLTAGE MULTIPLIER EMPLOYING SMALL SELENIUM RECTIFIERS AND HIGH FREQUENCY POWER-INPUT. B. Mitra, H. N. Raha, and B. Ghose (Bose Inst., Calcutta). Nucl. Instr. Methods, 32: 242-4(Feb. 1965).

A 250 kv Cockcroft-Walton accelerator is described, which uses small selenium rectifiers and r-f power at the input. When used as a (t,d) neutron generator drawing a beam current of 200 μamp, its voltage multiplication efficiency was experimentally determined to be close to 80 per cent. The h-f characteristic of single selenium cells used as voltage doubler was experimentally obtained up to 100 kc. Ripple percentage was observed to be greater than the theoretical value, but the shape of the ripple as observed in oscilloscope records, were unaltered for different leads, within limits. (auth)

11879 THEORETICAL ANALYSIS OF THE OVER-ALL CHARACTERISTICS OF THE POWER AMPLIFIER, R. F. CAVITY AND ACCELERATED BEAM IN A SYNCHROTRON C. H. M. Turner (Argonne National Lab., Ill.). Nucl. Instr. Methods, 32: 245-76(Feb. 1965).

The problems which arise in the r-f system of a synchrotron, as the intensity Q of the beam is increased are examined. An equivalent circuit for the r-f power amplifier, r-f cavity, and beam contains two independent current sources. The load loci on the tube characteristics are considered and expressions for the tube dissipation and power drawn from the line supply are obtained. The relations between their minimum values and the maximum beam that the system will handle are examined. Five different modes of operation are discussed. Two of them involve rectification and are non-linear; the other three are linear in operation and are studied in detail. It is found possible to construct a universal chart on which an overload polygon can be drawn, each side corresponding to a different kind of overload in the system. This polygon determines safe limits of operation in an existing system. It is recommended that the r-f system be aligned to system-resonance rather than open circuit resonance. It is shown that $Q_{max} = phCV_1$ where p is the distortion factor for delta-function bunches, h = harmonic number, C = effective capacity across accelerating gap, and V_1 = peak r-f potential. One way of comparing systems so as to be independent of the value of p arbitrarily assumed by a designer is through the value of (hCV_1). The greater (hCV_1) the greater is the beam that can be manipulated in a system. Some numerical values were given for the proposed r-f system of the Zero Gradient Synchrotron. (auth)

11880 STUDY OF A TUBE FOR ELECTROSTATIC ACCELERATOR OF VERY HIGH OUTPUT. G. Burnot and J. Lafoucriere (Institut de Physique Nucleaire, Lyon). Nucl. Instr. Methods, 32: 287-92(Feb. 1965). (In French)

The geometry of a high-intensity ion beam in an accelerator tube in which the electrostatic lenses have associated magnetic quadrupoles so as to compensate for the defocusing action of the space charge was determined. Several ways of investigating the problem are considered. (auth)

11881 DESIGN CONSIDERATIONS FOR HIGH-INTENSITY NEGATIVE ION SOURCES. K. W. Ehlers (Univ. of California, Berkeley). Nucl. Instr. Methods, 32: 309-16 (Feb. 1965). (UCRL-11365)

An attempt was made to improve the output of negative hydrogen ions, which are extracted directly from a hot-cathode Phillips-ion-gauge type of discharge. The discharge chamber was modified to accord with assumptions made as to the probable formation mechanism of the negative ions observed. Negative hydrogen ion currents in excess of 5 mamp were obtained. Ion source operating parameters, as well as considerations for the utilization of this discharge geometry by negative ion cyclotrons, are discussed. (auth)

11882 INJECTION OF IONS INTO A CYCLOTRON FROM AN EXTERNAL SOURCE. W. B. Powell and B. L. Reece (Univ. of Birmingham, Eng.). Nucl. Instr. Methods, 32: 325-32(Feb. 1965).

A technique is described which permits ions (deuterons) to be injected into a cyclotron from a point outside the magnet yoke. Use is made of a hole bored through the magnet along the axis of one of the poles. A focusing system consisting of a series of einzel lens units is inserted in the hole to reduce divergence of the beam due to space charge. On arrival at the median plane, the beam is deflected electrostatically through 90° into a system of grid wires situated in the dees, and accelerated to 12 Mev in the conventional manner. The energy of the deuteron beam during injection is 11 kev, and of 600 μamp entering the system, 21 μamp are obtained at full energy giving a net efficiency of 3.5%. The phase width of the circulating beam at full energy is found to be 70°. (auth)

11883 DIRECT EXTRACTION OF NEGATIVE ION BEAMS OF GOOD INTENSITY FROM A DUOPLASMATRON. G. P. Lawrence, R. K. Beauchamp, and J. L. McKibben (Los Alamos Scientific Lab., N. Mex.). Nucl. Instr. Methods, 32: 357-9(Feb. 1965). (LA-DC-6741)

A negative ion source was developed which delivers an H^- output of 80–100 μamp through a 0.9 mm duoplasmatron exit aperture. No appreciable electron current accompanies this directly extracted beam, and the source appears capable of providing large currents of negative ions other than H^-. It is therefore of interest for use with 2 and 3 stage Van de Graaff accelerators and especially as a source of ions for klystron bunching through such machines. (C.E.S.)

11884 NOMOGRAM FOR DESIGNING REGULAR SECTION OF ELECTRON LINEAR ACCELERATORS. Kotaro Oshima (Tokyo Shibaura Electric Co., Ltd.). Oyo Butsuri, 33: 317-21(May 1964). (In Japanese)

In design of electron linear accelerators, a large number of parameters, such as electron energy, electron beam current, microwave frequency and power, hole diameter of loading disks, length of accelerator tubes, Q of cavities, and conversion efficiency of the accelerator, are essential, and the relations among these parameters are very complicated. Charts that show numerical relations among these parameters are given and a nomogram for accelerator tubes is designed. The charts were prepared on the assumptions that the beam loading characteristics can be represented as $dP/dz = -2IP - 2iE$, the group velocity is proportional to the fourth power of the ratio of hole diameter of disks to wave length, and the ratio of fundamental special waves to total waves in the electric field can be expressed as a function of hole diameter of disks. In general, comparatively high conversion efficiency can be acquired at $P_L/P_0 = 0.04$. (auth)

11885 IMPROVED METHOD OF ION BEAM EXTRACTION. W. Huizenga, H. De Kluiver, H. Postma, and M. S. I. Rageh (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Phys. Letters, 14: 103-4(Jan. 15, 1965).

A method for ion extraction from a source with protruding plasma is described, using a system of parallel grids in the extraction system to avoid distortions of the plasma boundary resulting from nonuniformity of the plasma density or from stray magnetic fields. The results of an experiment using a duoplasmatron, a three-grid extraction system, and a unipotential lens was found to be in agreement with a similar experiment in which the second and third grids are replaced by an external system of accelerating electrodes designed to produce the same potential difference. (L.B.S.)

11886 TRUDY MEZHDUNARODNOI KONFERENTSII PO USKORITELYAM: DUBNA, 21-27 AVGUSTA 1963 G.

(Proceedings of the International Conference on High-Energy Accelerators, Dubna, August 21-27, 1963). A. A. Kolomenskii, A. B. Kusnetsov, and A. N. Lebedev, eds. Moscow, Atomizdat, 1964. 1092p. (CONF-114)

The design, development, and operation of accelerators are discussed. Storage systems, injection, extraction, focusing, beam separation, shielding, beam control systems, and operational problems are considered. Separate abstracts are prepared for 131 of the 168 papers presented. Abstracts of 37 papers previously appeared in NSA (17: 33115, 33119, 33120, 33121, 33122, 35002, 36508, 36719, 36720, 36721, 40132, 40133, 40134, 40135, 40136, 40137, 40138, 40139, 40140, and 40141 and 18: 725, 731, 4366, 4367, 4368, 4374, 5887, 6048, 7028, 7364, 7365, 10684, 14805, 26170, 28191, 42211, and 44329). (C.E.S.)

For abstracts of individual papers see: 11887, 11888, 11889, 11890, 11891, 11892, 11893, 11894, 11895, 11896, 11897, 11898, 11899, 11900, 11901, 11902, 11903, 11904, 11905, 11906, 11907, 11908, 11909, 11910, 11911, 11912, 11913, 11914, 11915, 11916, 11917, 11918, 11919, 11920, 11921, 11922, 11923, 11924, 11925, 11926, 11927, 11928, 11929, 11930, 11931, 11932, 11933, 11934, 11935, 11936, 11937, 11938, 11939, 11940, 11941, 11942, 11943, 11944, 11945, 11946, 11947, 11948, 11949, 11950, 11951, 11952, 11953, 11954, 11955, 11956, 11957, 11958, 11959, 11960, 11961, 11962, 11963, 11964, 11965, 11966, 11967, 11968, 11969, 11970, 11971, 11972, 11973, 11974, 11975, 11976, 11977, 11978, 11979, 11980, 11981, 11982, 11983, 11984, 11985, 11986, 11987, 11988, 11989, 11990, 11991, 11992, 11993, 11994, 11995, 11996, 11997, 11998, 11999, 12000, 12001, 12002, 12003, 12004, 12005, 12006, 12007, 12008, 12009, 12010, 12011, 12012, 12013, 12014, 12015, 12016, and 12694.

11887 THE CERN DESIGN STUDY FOR A 300-Gev PROTON SYNCHROTRON. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 40-7(1964).

Design parameters for a 300-Bev proton synchrotron are discussed. The aperture magnet and power supply, the r-f system, injection, controls, vacuum, expected performance, experimental layout and utilization, site problems, manpower, time schedule, and cost are considered. (C.E.S.)

11888 INJECTION INTO A 300-Gev PROTON SYNCHROTRON. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 48-57(1964).

The influence of the injection energy on the parameters of the 300-Bev proton synchrotron and the characteristics and requirements of injection from an alternating gradient proton synchrotron are discussed. The injection energy and injection field, the injection field and orbit distortions, space charge limits, limits to the accelerating system, AGS injectors, properties of a fast cycling booster, requirements of booster injection, beam intensity, and the high intensity parasitic beam are considered. (C.E.S.)

11889 HIGH-ENERGY ACCELERATOR WITH AN ADDITIONAL CONTROL PARTICLE BEAM. N. I. Doinikov, E. G. Komar, N. A. Monoszon, V. A. Titov, and I. S. Shukeilo (Efremov Scientific-Research Inst. of Electrophysics Instrumentation, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 58-64(1964). (In Russian)

A 1000-Bev proton synchrocyclotron that uses an auxiliary beam in order to monitor the magnetic field spatial distributions is discussed. The synchrocyclotron use a 100 to 200-Mev linear accelerator as an injector. The parameters of the synchrocyclotron, and the linear accelerator are presented, and the extraction of the beam from the linear accelerator is discussed. (C.E.S.)

11890 A 1000 Gev CYBERNETIC ACCELERATOR. E. L. Burshtein, A. A. Vasil'ev, and A. L. Mints (Radiotechnical Inst., Academy of Sciences, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 67-74(1964). (In Russian)

The main considerations that serve as the basis for the development of a 1000-Bev accelerator having automatic control of the magnetic field are presented. A general description of the basic systems of the accelerator is included. Automatic stabilization of betatron oscillations, control of the instantaneous equilibrium orbit, and the system for correcting injection errors are discussed. (C.E.S.)

11891 PROTON RING SYNCHROCYCLOTRON AND THE PROTON-ANTIPROTON STORAGE RINGS WITH NONLINEAR FOCUSING. Yu. F. Orlov (Inst. of Physics, Erivan). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 90-6(1964). (In Russian)

The principle of the nonlinear focusing is given. The theory of the ring synchrocyclotron (the magnetic field is constant in time) with a nonlinear focusing is treated. The stability of the linear vertical oscillations is provided by the phase stability of the nonlinear radial oscillations, by means of which the amplitudes of the radial oscillations oscillate about the needed mean value. The phase stability is achieved by a high-frequency transverse electromagnetic field, the frequency of which is changed according to the given program in accordance with the increase of the particle momentum and the requirements of stability. The principal calculations of the ring synchrocyclotron with energy $10-10^3$ Bev are given. The accelerators of such a type have considerable advantages compared with the strong focusing accelerators: the mean intensity of the accelerated beams is higher by an order of 3–5, the magnetic field is constant in time. The phase volume, which is significantly larger, makes it possible to store (by means of multiturn injection) and to accelerate in the ring synchrocyclotron such currents of antiprotons, that make possible the experiments with colliding beams of protons and antiprotons; in practice this is not possible in a strong focusing accelerator. The principal schemes of the proton–antiproton storage ring are examined. (auth)

11892 STATUS REPORT ON THE CERN PROTON SYNCHROTRON. P. H. Standley (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 99-109 (1964).

A survey is given of the present status of the CERN Proton Synchrotron and of its development since the 1961 Conference on High Energy Accelerators. (auth)

11893 PRECISION SURVEYING FOR THE 33 Gev SYNCHROTRON AT BROOKHAVEN NATIONAL LABORATORY. O. S. Reading (Brookhaven National Lab., Upton, N. Y.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 116-28(1964). (BNL-7203)

The 240 magnets around a circle of 806 meters circumference were adjusted to one tenth millimeter of their specified positions. The special devices and modifications of first order surveying instruments used to accomplish this work with high efficiency are described. Length measurements of the 33 meter intervals between the control stations are made with a root mean square error of twenty microns and closure adjustments to the angle measurements have been 0.08 seconds. The precautions adopted to insure such precision are described. Data are included on the stability of the machine foundations in the sand and gravel moraine soil as measured by surveys in the three years since the completion of the accelerator. (auth)

11894 GENERAL REVIEW OF THE OPERATION OF THE 7-Gev ITEP PS. L. Z. Barabash, L. L. Goldin, P. I. Zenkevitch, Yu. S. Pligin, Yu. P. Sivkov, M. I. Veselov, A. N. Talyzin, and V. A. Shchegolev (Inst. of Theoretical and Experimental Physics, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 137-45(1964). (In Russian)

General parameters of the ITEP PS as well as the energy and intensity of accelerated proton beam, the operating regime, and information about difficulties are presented. The form of the equilibrium orbit and its time variation as well as the deformations of the magnet foundation and magnet blocks displacements are considered. Methods of improvement of the form of equilibrium orbit are discussed and corresponding experimental results are given. Capture of particles into the acceleration process is discussed and

some considerations are given on particle bunching in very strong focusing machines. (auth)

11895 STATUS OF THE ARGONNE 12.5-Gev ZERO GRADIENT SYNCHROTRON. L. C. Teng (Argonne National Lab., Ill.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 187-96(1964).

The development status of the Argonne ZGS is described. The injection system, synchrotron magnet, vacuum chamber, d-c steering magnet and extraction, internal targetry, control system, and experimental equipment are discussed. (C.E.S.)

11896 REVIEW REPORT ON THE SERPUKHOV 60-70 Gev PROTON SYNCHROTRON. V. V. Vladimirskii (Inst. of Theoretical and Experimental Physics, USSR), L. L. Goldin, D. G. Koshkarev, et al. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 197-201(1964). (In Russian)

Changes made in the design since 1959 are discussed. A brief review of the current status of the construction and the magnet manufacturing is given. The most essential alteration in the design is an increase of the lengths of some straight sections between magnets to improve conditions for ejection of particles from the accelerator. (auth)

11897 THE FRENCH 60 Gev PROJECT. G. Bronca, R. Florent, M. Gouttefangeas, R. Levy-Mandel, R. Maillet, G. Neyret, and J. Parain. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 202-3(1964).

The reasons for the choice of a 60-Bev proton synchrotron are briefly summarized. The main characteristics of the project are given. Some technical and financial evaluations are indicated. Present status and future plans are reported, aiming for a machine available in 1971–1972. (auth)

11898 STATUS REPORT ON NIMROD, THE 7 Gev PROTON SYNCHROTRON AT THE RUTHERFORD HIGH ENERGY LABORATORY. P. Bowles, H. C. Brooks, P. D. Dunn, D. A. Gray, G. S. Grossart, L. C. W. Hobbis, J. C. Louth, and L. B. Mullet (Rutherford High Energy Lab., Harwell, Berks, Eng.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 204-12(1964).

Construction of Nimrod, the 7-Bev proton synchrotron at the Rutherford High Energy Laboratory, is in its final stages and the overall commissioning of the machine is imminent. The magnet power supply, magnet, r-f system, and the injector have been working satisfactorily for some time while the vacuum system has advanced to the stage where adequately low pressures were reached in several octants. A summary is given of the performance of these principal components and their characteristics as measured to date with special attention to the magnet field survey. (auth)

11899 A 6 TO 7 Gev PROTON SYNCHROTRON, THE INJECTOR FOR A 1000-Gev CYBERNETIC ACCELERATOR. F. A. Vodopyanov (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoretelyam, Dubna, 1963, 213-16(1964). (In Russian)

The main requirements imposed on the injector for a cybernetic accelerator are discussed. It is shown that a proton synchrotron having 50 accelerator cycles per second can be used as the injector. The main parameters for this 6–7 Bev injector are presented. (auth)

11900 THE DESIGN OF A 1-Gev CYBERNETIC ACCELERATOR. G. I. Batskikh, A. A. Vasil'ev, A. I. Dzergatch, A. L. Mints, and N. L. Sossenskii (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 217-21(1964). (In Russian)

From an analysis of the design of a 1-Bev cybernetic accelerator it is shown that the use of automatic control systems makes feasible the construction of an accelerator having reduced magnetic system tolerances, a vacuum chamber with a small aperture, and a magnet of light weight. (auth)

11901 PERFORMANCE OF THE CAMBRIDGE ELECTRON ACCELERATOR. G. A. Voss (Massachusetts Inst. of Tech., Cambridge and Harvard Univ., Cambridge, Mass.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 222-6(1964).

Since December 1962 the Cambridge Electron Accelerator has been in routine use for experiments. Energies were between 1 and 6 Bev with currents as great as 5×10^{10} electrons/pulse (3×10^{12} electrons/sec). At present the accelerated current is limited by beam loading effects in the r-f cavity system, the effects being aggravated by orbit distortions at injection. A major technical problem is radiation damage to those vacuum chambers that follow internal targets. The (0 to 30 kev) synchrotron radiation has produced no ill effects. Three photon beams and one positron beam (produced by a double conversion process) were put to use. A beam-bump system in which the equilibrium orbit is locally distorted at the end of the acceleration cycle was used to produce spill-times as long as 500 μs. The shielding of the CEA has proven to be adequate. Neutron backgrounds inside and outside of the project are below the permissible values. To date 8 experimental groups have made active use of the machine. During the first 6 months of operation, downtime due to component failure has averaged 19%. (auth)

11902 STATUS REPORT ON THE 6 Gev ELECTRON ACCELERATOR DESY. H. O. Wuester (Deutsches Elektronen-Synchrotron, Hamburg). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 227-31(1964).

The general design of the electron accelerator and the present status of the machine are discussed. (auth)

11903 THE DESIGN AND CONSTRUCTION OF THE VACUUM CHAMBER FOR THE 6 Gev ELECTRON ACCELERATOR DESY. G. Bathow (Deutsches Elektronen-Synchrotron, Hamburg). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 232-4(1964).

The vacuum chamber must consist of a material highly resistant against radiation damage and it must have low conductivity to avoid excessive eddy-currents. The inner surface must be conductive to avoid charging up effects. The structure of the vacuum chamber consists of different layers. The innermost layer is formed by a helically wound ribbon of titanium with a thickness of 1 mm. A layer of a mixture of a low melting glass and aluminum oxide is sprayed on this titanium surface in the flame. Since the coefficient of thermal expansion is the same for both materials this inner part of the chamber forms a vacuum-tight wall which will not be cracked by thermal stresses. To give the whole structure the necessary mechanical strength a thick layer of epoxy resin reinforced by two other layers of titanium ribbon with a thickness of 0.3 mm is put upon the inner titanium glass layer. (auth)

11904 THE 6 Bev ELECTRON SYNCHROTRON OF EREVAN. Yu. G. Agbalyan (Physical Inst., Armenian SSR), A. I. Alikhanyan, A. Ts. Amatuni, et al. Tr. Mezhdunar Konf. po Uskoritelyam, Dubna, 1963, 235-9(1964). (In Russian)

The principal parameters and the specific features of the calculation and construction of the Erevan 6-Bev strong focusing electron synchrotron are given. The construction is described, and the principal parameters of the separate assemblies of the accelerator (electromagnet, its feed system, the elements correcting the magnetic characteristics, the linear accelerator, the injection system, the accelerating system, the vacuum chamber and vacuum system, the ejection system) are given. The conditions of the building, assembling, and adjusting works of the accelerator are also discussed. (auth)

11905 CORNELL 2 Gev ELECTRON SYNCHROTRON WITH LONG STRAIGHT SECTION— UNDER CONSTRUCTION. B. D. McDaniel (Cornell Univ., Ithaca, N. Y.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 240(1964).

The design of a guide field magnet and its r-f system that are being prepared for the Cornell electron synchrotron is discussed. When the magnet is installed, the maxi-

mum operating energy of the synchrotron will be increased from about 1.3 Bev to over 2.0 Bev. (C.E.S.)

11906 THE PROPOSED CORNELL 10 Gev ELECTRON SYNCHROTRON. R. R. Wilson (Cornell Univ., Ithaca, N. Y.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 241-5(1964).

The design of a 10-Bev electron synchrotron is discussed. A magnet with an orbit radius is proposed to decrease the electron beam radiation losses. The magnet is discussed in detail, and models are illustrated. The linac injector and the vacuum system are also considered. (C.E.S.)

11907 THE ORSAY PROJECT OF A STORAGE RING FOR ELECTRONS AND POSITRONS OF 450 Mev MAXIMUM ENERGY. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 288-94(1964).

The electron-positron storage ring for the Orsay Linear Accelerator is described. The structure comprises eight magnet sections of field index 0.5. Four of the eight straight sections are occupied by each of a set of three quadrupoles. The other four straight sections are intended for injection in both directions, for the r-f cavity, and two for experimental equipment. The orbit and beam characteristics and injection are discussed. (C.E.S.)

11908 THE ARRANGEMENT FOR COLLIDING 2 × 100 Mev ELECTRON BEAMS. A. K. Val'ter (Inst. of Physics and Tech., Khar'kov), Yu. N. Grigor'ev, I. A. Grishaev, et al. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 295-9(1964). (In Russian)

Data on the design of the experiment on the electron and positron storage are reported. The problems of the choice of the storage ring parameters and of providing a necessary accuracy are considered. The results of the storage system parts and the status of the work on the positron beam generation at linac are presented. (auth)

11909 RECENT U. S. WORK ON COLLIDING BEAMS. L. W. Jones (Univ. of Michigan, Ann Arbor). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 300-11(1964).

The use of colliding beams for experiments in elementary particle physics is explored with particular reference to a system of storage rings which could be added to the Brookhaven Alternating Gradient Synchrotron. Possible interesting experiments are outlined, and the requisite stacked beam intensities, phase space densities, and other characteristics are presented. The range of accessible physics and limitations of the technique are discussed. Further applications of colliding beams to future higher energy synchrotrons are also considered. (auth)

11910 SOME PROBLEMS CONNECTED WITH THE USE OF INTERSECTING PROTON STORAGE RINGS. K. Johnsen, W. C. Middelkoop, B. de Raad, L. Resegotti, A. Schoch, K. R. Symon, and C. J. Zilverschoon (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 312-25(1964).

A colliding beam experiment consists of an arrangement of magnets and detectors placed around the intersection region in such a way that they yield a maximum amount of information about the reaction under investigation but cause a minimum disturbance to the circulating beams. A considerable fraction of the secondaries will be produced at such small angles that there is no place for separate analyzing magnets, but if they are suitably constructed the storage ring magnets adjacent to the intersection region can be used as analyzing magnets for small angle reaction products. The resolving time, spatial resolution, and versatility of spark chambers make them the most suitable detectors. The layout of some simple experiments is discussed. Possible designs for the shielding and buildings around the intersection regions are given. (auth)

11911 CONSIDERATIONS ON RF SYSTEMS FOR INTERSECTING PROTON STORAGE RINGS. W. Schnell (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 326-31(1964).

The problems presented by the radio frequency system of a pair of storage rings of the CERN proton synchrotron are discussed. In order to meet the most difficult case which might arise it was assumed that a rather complicated non-repetitive, stacking scheme is used, which should lead to good stacking efficiency even with a relatively small number of stacked pulses. Problems of programming the r-f amplitude and frequency, timing, frequency noise, matching to the proton synchrotron, and the design of the r-f cavities and associated amplifiers are discussed. Since the number of pulses to be stacked will be, in general, very large, it is probably possible to use simpler, repetitive, stacking schemes. The implication of this type of stacking scheme on the design of the r-f system is also discussed. (auth)

11912 LIFETIME AND BEAM SIZE IN ELECTRON STORAGE RINGS. C. Bernardini (CNEN, Frascati, Italy), G. F. Corazza, G. Di Giugno, G. Ghigo, R. Querzoli, J. Haissinski, P. Marin, and B. Touschek. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 332-7(1964).

Experimental and theoretical effects concerning the properties of beams in an electron-electron or electron-positron storage ring are discussed. Only those properties affecting the reaction rates are considered. Equations are developed for beam size and lifetime. Problems arising from d-c fields occurring because of poor shielding, r-f transverse fields due to cavity misalignments, fields due to ions in the vicinity of the beam path, and image effects on the metal environment of the beams are also considered. (C.E.S.)

11913 THE CERN ELECTRON STORAGE RING MODEL. F. A. Ferger, E. Fischer, E. Jones, P. T. Kirstein, H. Koziol, and M. J. Pentz (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 338-46(1964).

The design and construction of a strong focusing storage ring is described. The ring is designed for beam stacking experiments with electrons up to 100 Mev or protons up to about 5 Mev. Initial experiments will be with 2-Mev electrons from a pulsed Van de Graaff injector. (auth)

11914 ULTRAHIGH VACUUM FOR STORAGE RINGS. E. Fischer (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 347-52(1964).

The ultrahigh vacuum system of the CERN Electron Storage Ring Model can be regarded as a typical solution for accelerators requiring a pressure between 10^{-8} and 10^{-10} torr. The main pumps are titanium sputter pumps of the Penning type, the ultimate pressure of which lies in the range of 10^{-11} torr. The gas desorption from the stainless steel chamber is reduced by electrolytic polishing and by bake-out at 300°C. Desorption rate and gas composition are measured. The main temporary difficulty is the leak tightness of special components such as inflector tanks. A working pressure in the 10^{-10}-torr range was proved feasible. (auth)

11915 PARTICLE STORAGE IN A SYNCHROTRON. Yu. M. Ado, K. A. Belovintsev, A. Ya. Belyak, E. G. Bessonov, O. B. Dem'yanovskii, V. A. Skorik, P. A. Cherenkov, and V. S. Shirchenko (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 355-7(1964). (In Russian)

Recently there was found an interesting possibility of an accelerator use of a synchrotron type with the energy of several hundred Mev as a particle accumulator. This method realizes the acceleration and accumulation function in one apparatus. Accumulating simultaneously electrons and positrons in the accelerator one can obtain colliding electron-positron beams. A relatively small injection energy into the synchrotron and the varying guide magnetic field contribute to the problem of particle injection into the accumulation regime. Besides, a small injection energy essentially simplifies the problem of obtaining positrons. These peculiarities permit one to obtain

comparitively great accumulation velocities and thus decrease the requirements for vacuum. Taking into account the prospects of the considered method of accumulation for colliding beams, experiments were performed to check the principal possibilities of its realization. Experiments were performed on the 280-Mev synchrotron of the P.N. Lebedev Phys. Institute of the USSR Academy of Sciences. A microtron with 7 Mev energy was used as an injector. The results obtained confirm the possibilities of the synchrotron use as an accumulator. (auth)

11916 EFFECT OF SYNCHROTRON RADIATION ON COLLIDING BEAMS IN STORAGE SYSTEMS. Yu. M. Ado (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 358-60(1964). (In Russian)

Calculations are presented for particle losses due to synchrotron radiation in a colliding-beam electron-positron storage system. The number of positrons and electrons in the storage system is 10^{11}. Particle losses due to beam collisions with atoms in a vacuum of 10^{-10} mm Hg are estimated, and compensation for particle losses is discussed. (C.E.S.)

11917 INTERACTION OF INTERSECTING BEAMS IN STORAGE SYSTEMS. A. A. Kolomenskii, A. N. Lebedev, and A. P. Fateev (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 365-7 (1964). (In Russian)

Several problems concerning the electromagnetic interaction of intersecting beams moving in storage systems are considered. It is shown (numerically and analytically) that taking into account interaction of the beams results in distortion of the orbit and a decrease in the effective angle of collision and in a change in the frequency of betatron oscillations. The indicated distortion of the orbit increases particularly sharply in certain special (resonance) cases. At a certain limiting particle density, the beams will no longer intersect and they go over to new stable orbits. In the presence of distortion of the median plane there appear additional forces resulting in twisting of one beam relative to the other. (auth)

11918 ON THE STABILITY OF COLLIDING INTERSECTING BEAMS IN STORAGE RINGS. E. M. Moroz (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 368-71(1964). (In Russian)

Various kinds of distortions of orbits due to electromagnetic action of intersecting bunches in electron-electron and electron-positron storage rings which may result in no collisions occurring when about 10^8 particles are stacked in intersecting bunches are investigated. By properly choosing the storage-ring parameters, one can defer the onset of instabilities of the investigated type until about 10^{10} particles of each sign are stacked. Methods of obtaining constrained collisions between intersecting bunches of particles are also considered. (auth)

11919 CHOICE OF AN OPERATING POINT FOR A POSITRON ELECTRON STORAGE RING. B. Richter and D. Ritson (Stanford Univ., Calif.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 372-5(1964).

Formulas were worked out for the changes in adjustment, and in tilt angle for electron-positron beams separated by an electric field and crossing at two interaction regions in a storage ring. When an odd harmonic electric field is used to split the beams, the operating point should be chosen to lie just above an even integer resonance. If an even harmonic field is chosen, the operating point should be chosen to lie just above an odd integer resonance. (auth)

11920 TRANSVERSE SPACE-CHARGE EFFECTS IN SYNCHROTRON AND STORAGE RINGS. F. Fer and C. Delcroix (Université, Paris). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 376-82(1964).

Space-charge effects in the electron-positron collisions in storage rings are discussed. It is supposed that both beams have the same equilibrium trajectory and therefore meet front to front. Simplifying assumptions are made for the calculations of the forces the electron beams create on a positron. It is then shown that there exist several regions of stability when the density is increasing from zero. The end of the first region is about 10^{11} electrons/cm^3; the beginning of the second is about 10^{13}. (auth)

11921 STABILITY OF THE MOTION OF ACCELERATED ELECTRONS IN STORAGE RINGS AND RELATED EXPERIMENTS. F. Fer (Université, Paris). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 383-91(1964).

Calculations of the damping coefficients for the betatron and phase oscillations are presented. The exact linear equations of oscillations are derived from the Lorentz-Abraham relativistic equations of motion for the accelerated electron in a F.F.A.G. field. The solutions are expanded with respect to the parameter e^2/m_0 which commands the radiating factor, and the damping coefficients so obtained. The values of these latter are in agreement with F. E. Mill's values, excepted on one point: the value of the phase damping coefficient is valid only for energies lower than about 100 Bev; beyond that, phase stability is impossible. (auth)

11922 ON PARTICLE INJECTION IN ELECTRON-POSITRON STORAGE RING. Yu. N. Metal'nikov and V. A. Petrukhov (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 392-5 (1964). (In Russian)

A possible version of particle injection in electron-positron storage rings when it uses a synchrotron as an injector-accelerator is discussed. The electrons and positrons are born in targets put in the storage ring chamber and exposed to the γ beam of the synchrotron. Capture is made with the help of inflector magnets situated in straight intervals of the storage ring and covering the whole working area on the radius and vertical axis. Computations made for the proper version of the storage ring show that it is possible to provide a capture factor (the ratio of positron or electron number captured within storage regime to electron number of the synchrotron orbit for every working cycle of synchrotron) of $\sim 3 \times 10^{-5}$. The parameters of the inflector power system are quite acceptable. The computations show that no synchronization between inflector devices and the r-f-system of the storage ring and synchrotron is needed. (auth)

11923 NEW METHOD TO OBTAIN QUASIMONOCHROMATIC AND POLARIZED HIGH ENERGY γ-QUANTA. F. R. Arutyunyan, I. I. Gol'dman, and V. A. Tumanyan (Inst. of Physics, Erevan). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 400-2(1964). (In Russian)

It is shown, that the Compton scattering of the soft photons by the relativistic electrons produces γ quanta with an energy close to the energy of the electrons. The calculations show that γ quanta generated in this manner are highly polarized and have an energy spectrum that differs from the bremsstrahlung spectrum. The estimations show that the use of powerful sources of soft photons in modern electron accelerators (for example lasers) makes it possible to obtain sufficiently intensive beams of γ quanta that have a convenient energy spectrum and a high degree of polarization. (auth)

11924 PROGRESS REPORT ON THE STANFORD TWO-MILE LINEAR ACCELERATOR. W. K. H. Panofsky (Stanford Univ., Calif.). Tr. Mezhdunar Konf. po Uskoritelyam, Dubna, 1963, 407-19(1964).

Construction on the accelerator site started in July 1962 and the current status of the plant is discussed. Design decisions on the accelerator fabrication technique, method of phasing, klystron amplifiers, high-power modulators, support and alignment, injection and vacuum are described. A beam transport system into several target areas was developed which preserves the optical quality and the time structure of the beam. Separate target area concepts for the production of secondary beams for the study of electrons and photon interactions, and for neutrino experiments were developed. (auth)

11925 THE TRAVELING-WAVE LINEAR 2 Bev ACCELERATOR. A. K. Valter (Inst. of Physics and Tech., Khar'kov), I. A. Grishaev, E. V. Erimenko, et al. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 420-5 (1964). (In Russian)

Results of the adjustment of major components of the accelerator are described. The considerations on the choice of high energy section accelerator parameters are listed. On the grounds of the methods of the accelerator adjustment and exploitation, considerations about accelerator beam parameters are presented. (auth)

11926 THE 1.3 Gev ELECTRON LINEAR ACCELERATOR OF ORSAY. L. Burnod (Université de Paris, Orsay, France). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 425-9(1964).

The experimental characteristics of the Linear Accelerator of Orsay, which has been working at the nominal energy of 1 Bev for the past 18 months (energy-current-utilization duties), are described. The extension to 1.3 Bev is being performed as well as a system for automatic phasing of the wave with respect to the electrons. (auth)

11927 THE SELECTION OF THE OPTIMAL PARAMETERS FOR A HIGH ENERGY LINEAR ACCELERATOR. G. A. Zeitlenok, Yu. P. Lazarenko, V. M. Levin, K. A. Reshetnikova, V. V. Rumyantsev, and A. V. Ryabtsev (Scientific-Research Inst. of Electrophysical Apparatuses, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 430-4(1964). (In Russian)

The problems encountered in minimizing the cost of an electron beam loaded linac are considered. Simple approximate formulas for the calculation of the cost and selection of the optimum basic parameters for accelerating sections are obtained. It is shown that in a high current accelerator the Slater's condition concerning the equality of length cost and r-f supply cost is not always correct. Some known accelerators having a constant field and a constant geometry of waveguide unit are reviewed. (auth)

11928 THE TRAVELING-WAVE LINEAR 360 Mev ACCELERATOR. A. K. Valter (Inst. of Physics and Tech., Khar'kov), I. A. Grishaev, L. A. Makhnenko, A. I. Zykov, G. K. Demyanenko, G. A. Zeitlenok, I. F. Malishev, F. F. Furkin, and V. K. Khokhlov. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 435-9(1964). (In Russian)

The adjustments and research results of the accelerator components are described. The beam formation and the longitudinal movement of the beam in the accelerator are discussed. The results of different accelerating system efficiency measurements are presented. Component reliability and parameter accelerator stability are considered. (auth)

11929 THE CONSTANT PHASE VELOCITY ELECTRON INJECTOR ACCELERATOR. V. A. Vishnyakov, I. A. Grishaev, A. I. Zykov, and E. K. Ostrovskii (Inst. of Physics and Tech., Khar'kov). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 440-3(1964). (In Russian)

With a view to provide the best condition of the injection into high energy accelerators the theoretical and experimental characteristics of the accelerator with constant phase velocity close to light velocity are researched. The accelerator optimum version at the energy 6 Mev was chosen and a possibility of the realization of good parameters was shown. (auth)

11930 STRUCTURES FOR HIGH ENERGY PROTON LINEAR ACCELERATORS. A. Carne (Rutherford High Energy Lab., Harwell, Berks, Eng.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 444-51(1964).

The design of high-energy proton linear accelerators based on the clover-leaf and the crossed-bar structures is considered. In the clover-leaf structure the magnetic field lines are distorted by the nose cones into a clover-leaf pattern and so introduce radial components into the field. Each cavity is coupled to its neighbor by eight equally spaced radial slots, and the nose cones of adjacent cavities are oriented at 45° to one another. The crossed-bar structure consists of a circular waveguide loaded by circular bars at right angles to each other. At the center of each bar is a drift tube to improve the axial field from factor and so improve the transit time factor. (C.E.S.)

11931 PROTON LINEAR ACCELERATOR STRUCTURE FOR INTERMEDIATE VELOCITIES. R. Beringer (Yale Univ., New Haven). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 452-3(1964).

Design problems in developing proton linear accelerators of several hundred Mev are considered. The principal problem is the relative inefficiency of known structures at intermediate velocities. The falling shunt resistance of Alvarez drift-tube linear accelerators with increasing particle velocity is discussed, and several more efficient accelerating structures are considered. (C.E.S.)

11932 INJECTOR DESIGN FOR A 70 Gev PROTON SYNCHROTRON. I. M. Kapchinskii, V. G. Kul'man, N. V. Lazarev, B. P. Murin, I. Kh. Nevyazhskii, V. K. Plotnikov, and B. I. Polyakov (Radio-technical Inst., Academy of Sciences, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 462-7(1964). (In Russian)

A strong-focusing linac injector for a 70-Bev proton synchrotron is described. The linac consists of three cylindrical resonators with drift tubes. The proton beam is generated by a duoplasmatron source and is accelerated to 700 kev in a pulsed electrostatic tube. The proton energy at the injector exit is estimated to be 100 Mev. (C.E.S.)

11933 SOME PROBLEMS OF THE DESIGN OF LONG CAVITIES FOR LINEAR PROTON ACCELERATORS WITH DRIFT TUBES. V. G. Kulman and V. B. Chistov (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 468-70(1964). (In Russian)

Problems of basic geometry of cavities such as their ultimate length for an operating wavelength of 2m are discussed. Experimental data are presented on the effect of dimension changes on the resonant frequency and field distribution. Data are also given on long cavity models tuning with appreciable mode changes. A method for calculation of the tuning elements is considered. The results presented were used as a basis in designing a 100-Mev linear accelerator injector. (auth)

11934 AUTOMATIC CONTROL AND MEASUREMENT OF HF FIELD PARAMETERS IN THE 100-Mev LINEAR ACCELERATOR INJECTOR. A. D. Belov, B. P. Murin, and L. Yu. Solovev (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 471-4 (1964). (In Russian)

Results obtained in designing automatic control systems and h-f field parameters measurement systems for a 100-Mev linear proton accelerator serving as the injector for a 70-Bev synchrotron. Characteristics and circuit diagrams are included for the automatic control system of h-f field phase and of cavity natural frequencies as well as for automatic h-f amplitude and phase monitoring. (auth)

11935 HIGH CURRENT PERFORMANCE OF THE CERN PS LINAC. C. S. Taylor (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 475-88 (1964).

An account is given of the performance of the 50-Mev linac injector of the CERN Proton Synchrotron of accelerated currents of 50–60 mamp. Experimental results are presented for emittances, acceptance, energy spread, beam loading, and stability. (auth)

11936 OPERATIONAL EXPERIENCE WITH THE 2G INJECTOR. J. Abraham, R. W. Castor, P. V. Livdahl, W. Myers, and R. Perry (Argonne National Lab., Ill.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 499-506 (1964).

The 50-Mev proton linear accelerator injector had operated since October, 1962. Principal differences from other linear accelerators exist in the preaccelerator, r-f

system, quadrupole arrangement which operates in the +-+- mode, and the vacuum system. These differences are described and operational observations discussed. Measurements of beam characteristics and description of the equipment for measuring these characteristics are included. (auth)

11937 HIGH CURRENT INJECTOR FOR A STRONG-FOCUSING LINAC. M. A. Abroyan, V. P. Gerasimov, F. G. Zhelenznikov, et al. (Scientific-Research Inst. of Electrophysical Apparatuses, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 507-12(1964). (In Russian)

The problems concerning the development of a direct action accelerator with proton pulsed beam at 700 kev are considered. Methods of obtaining and forming the beam from the Duoplasmatron ion source and the stabilized system for accelerator high voltage power supply with pulsed transformer are discussed. The design technique of the ion-optical system, with the effect of the volume charge, is considered. Also the general relations connecting the beam parameters at the accelerating tube input and output are given. The experimental investigation data of ion-optical system providing the 400 mamp accelerator ion beam, are represented. Such beam was focused to the spot diameter 10 mm. (auth)

11938 CROSS-GRADIENT FOCUSING IN LINEAR ACCELERATORS. F. Fer (Université de Paris, Orsay, France), P. Lapostolle, C. Bieth, and A. Cabrespine. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 513-23 (1964).

The impossibility of having simultaneous phase and transverse stability under accelerating field forces in a linear accelerator, as stated originally by MacMillan, only applies if this field is uniformly distributed along the axis. In the case of a periodic distribution, one can obtain a strong focusing effect which provides stability in both longitudinal and transverse directions. An example is presented where the circular holes in the drift tubes of a linear accelerator are replaced by rectangular slits alternatively oriented in two orthogonal transverse directions. A typical application to a heavy ion linear accelerator is presented. Such a focusing scheme is very easy to construct and offers very interesting possibilities. (auth)

11939 ACCURATE ENERGY MEASUREMENTS ON A 50 Mev PROTON LINEAR ACCELERATOR. K. Batchelor, A. Carne, J. M. Dickson, and D. J. Warner (Rutherford High Energy Lab., Chilton, Berks, Eng.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 524-34(1964).

Energy measurements were carried out on the three accelerating sections of the Rutherford High Energy Laboratory Proton Linear Accelerator i.e., at 10, 30, and 50 Mev. The measurement utilizes a combination of accurate radio-frequency deflection of the input beam to the accelerator, thus increasing the proton burst spacing, and precise timing of the flight time of individual bursts over an accurately known distance at the end of the accelerator. The effect of various machine parameters on the output beam energies was determined, the main parameters used being radio-frequency field amplitude, inter tank phase, and field tilt. Computer programs were written, using step integration of the cavity fields, which enable one to compare the results with theory. (auth)

11940 STATUS OF RESEARCH AT STANFORD UNIVERSITY ON SUPERCONDUCTING ELECTRON LINACS. P. B. Wilson, H. A. Schwettman, and W. M. Fairbank (Stanford Univ., Calif.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 535-40(1964).

The Q of a superconducting microwave cavity was measured at 2856 Mc as a function of surface material, surface finish, temperature, r-f power level, and d-c magnetic field. An unloaded Q of 7×10^8 was since obtained with an electroplated lead surface at 1.9°K in a d-c magnetic field of .05 gauss. If the cavity is cooled in a higher magnetic field, the maximum Q that can be obtained is lower. This and other evidence indicates that trapped magnetic flux may be important in limiting the cavity Q. The maximum r-f magnetic field strength obtained so far at the cavity surface is 150 gauss with an input power of about 10 watts. However, the cavity Q decreases for power levels above a few watts. It is felt at present that this effect is the result of a temperature rise of the cavity due to heating. The design of the cavity and cryostat was modified to eliminate this possibility and to magnetically shield the cavity to less than a milligauss. The design of large superconducting electron linacs operating c-w or with high duty cycle is discussed. (auth)

11941 RADIO-FREQUENCY MEASUREMENTS ON SUPERCONDUCTORS FOR PROTON LINAC RESONANT CAVITIES. A. P. Banford (Rutherford Lab., Nirns, Eng.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 531-3 (1964).

Surface resistivities relative to copper at room temperature were measured for a large number of superconducting specimens. These specimens are in the form of quarter wavelength twin lines or hairpins and are resonant at 400 Mc. The best results were obtained with electroplated lead and electropolished niobium, for which the surface resistivities at 4.2°K are less than the resistivity of copper at room temperature by factors of 9,000 and 12,000, respectively. A system using 5 cm diameter, 400 Mc, half wavelength coaxial resonators for high power tests is described. (auth)

11942 A 700 Mev RELATIVISTIC PROTON CYCLOTRON. A. A. Glazov (Joint Inst. for Nuclear Research, Dubna, USSR), Yu. N. Denisov, V. P. Dzhelepov, et al. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 547-55(1964). (In Russian)

The results of theoretical calculations and design considerations performed in connection with studying the possibility of constructing a 700-Mev relativistic proton cyclotron with current of hundreds of microamperes are considered. It was assumed that the electromagnet of the accelerator under study has a construction which is usually used in cyclotrons and synchrocyclotrons. The magnetic field, which provides spatial stability of particle motion in the accelerator, changes periodically azimuthally and radially. A necessary variation of the field strength in the electromagnet gap is formed by a system of rectangular iron shims cut in an Archimedean spiral which are located symmetrically with respect to the gap median plane. The optimum parameters of such a magnetic system with the pole diameter 700 cm were found. The law of changing the average value of the field strength along the radius is provided by the profile of pole-tips and also by additional shimming by means of concentric coils flowed by current located on the upper and lower lids of the vacuum chamber. The accelerating system is shaped in the form of two 180° dees presenting quarter-wave cuts of an inhomogeneous line (the wave-length is 25 m). If the maximum energy gain is 400 kev per turn, power supplied to the radio-frequency system is about 3000 kw. The problems of secondary particle generation and of the transportation of the proton beam extracted from the cyclotron are considered taking into account the most effective utilization of the accelerator possibilities. The scheme of shielding against accelerator radiation was worked out taking into account the necessity of providing favorable conditions for maintenance and repairing of the accelerator and of reducing radiation background in experiments. (auth)

11943 MAGNETIC FIELD OF A 700 Mev RELATIVISTIC PROTON CYCLOTRON. V. P. Dmitrievskii, N. L. Zaplatin, V. S. Rybalko, and L. A. Sarkisyan (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 556-60(1964). (In Russian)

The problems of obtaining the magnetic field of a 700-Mev relativistic cyclotron with space variation are discussed. It was shown that the required field may be obtained by means of the system of spiral shims located between the dome-shaped poles of the electromagnet. Calculation formulas permitting one to determine the distri-

bution of the magnetic field of the system of spiral shims are given. It is shown that the approximate designing of the magnetic field variation of the system of spiral shims with the aid of rectangular ferromagnetic bars is possible. Based on the theoretical and experimental investigation of the magnetic field of the rectangular shim system the main parameters of the cyclotron magnetic system (the limit working radius, spirality, shim thickness, and height) and also the profile of the spiral shims were chosen. The choice of the profile of the pole tips and a more exact determination of the profile of spiral shims were made by designing the magnetic system of the cyclotron with the scale $K \sim 1/4$. The parameters of the magnetic system of the relativistic cyclotron are reported providing the required variation law to be within the given tolerances, and the average magnetic field is obtained to an accuracy of $\pm 5 \times 10^{-3}$. (auth)

11944 AN ISOCHRONOUS CYCLOTRON MESON FACTORY. R. S. Livingston and J. A. Martin (Oak Ridge National Lab., Tenn.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 561-7(1964).

Studies indicate that proton beams and secondary particle beams of very high intensity can be produced with an eight-sector isochronous cyclotron. The operation of an electron analog at an energy corresponding to $v/c = 0.87$ has demonstrated the transmission of the beam without loss to full energy. Extraction studies in the same electron model have established the feasibility of efficient extraction of the full-energy circulating beam by utilizing the 3/4 radial resonance. Other features of the high intensity machine were studied. Methods of analysis of the production of residual radioactivity were developed and verified by experiments. It is concluded that the areas of most intense radioactivity can be limited to the external targets, where remote handling and special shielding can be used. The magnet systems for high dispersion beam analysis can provide beams suitable for precision experimental work. A series of heavily shielded experiment rooms is planned, designed to permit operation with proton and meson beams at full intensity without jeopardizing or limiting staff personnel working in adjacent laboratories. (auth)

11945 GENERAL DESIGN AND FEATURES OF NEGATIVE ION CYCLOTRONS. R. P. Haddock, K. R. Mackenzie, J. R. Richardson, and B. T. Wright (Univ. of California, Los Angeles). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 568-77(1964).

The influence of electric and gas dissociation on the design of a high-energy AVF negative ion cyclotron is discussed. Results of a design study of a 625-Mev machine are presented. The unit has the following features: The duty factor is flexible, offering potential variation from macroscopic 100 per cent, microscopic 80 per cent to macroscopic few per cent, microscopic few per cent. Simultaneously several beams of differing or the same energy may be extracted. Up to 150 microamperes of external beam can be produced without undue activation of the cyclotron itself. The extracted beam is of high quality. The production and use of neutral external beam is discussed. (auth)

11946 INTERNAL BEAM CURRENT INCREASE IN THE 680 Mev SYNCHROCYCLOTRON OF THE JOINT INSTITUTE OF NUCLEAR RESEARCH. V. I. Danilov, I. B. Enchevich, B. I. Zamolodchikov, B. N. Marchenko, D. L. Novikov, E. A. Polferov, E. I. Rozanov, A. L. Savenkov, A. N. Safonov, and A. V. Shesmov (Joint Inst. of Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 591-4(1964). (In Russian)

The phase motion in the 680-Mev proton synchrocyclotron was analyzed in two stages, that is, the capture of particles in the center of the synchrocyclotron and the phase motion in the accelerating process to the final radius, in an attempt to increase the beam current. Proton energy and intensity were determined as a function of orbit radius. The internal beam current was increased to ~2.3 μamps. (C.E.S.)

11947 CALCULATION OF THE INITIAL REGION OF STABLE PHASE OSCILLATIONS IN SYNCHROCYCLOTRONS. V. I. Danilov, I. V. Enchevich, D. L. Novikov, E. A. Polferov, A. N. Safonov, and B. V. Feoktistov (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 595-9(1964). (In Russian)

Proton phase motion in the central region of a synchrocyclotron was analyzed by means of the equations of motion for a charged particle in the electric and magnetic fields of the accelerator. The analysis was limited to charged particle motion in an axially symmetric magnetic field. (C.E.S.)

11948 THE BASIC CHARACTERISTICS OF ISOCHRONOUS CYCLOTRON WITH VARIABLE PARTICLE ENERGY. A. G. Alekseev, Yu. G. Basargin, I. F. Zhukov, I. F. Malyshev, Yu. K. Lavrentev, R. N. Litunovskii, N. P. Nevrov, A. V. Stepanov, and I. V. Tuzov (Scientific-Research Inst. of Electrophysical Apparatuses, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 600-3(1964). (In Russian)

The basic experimental results of investigations carried out on the technical design development of a cyclotron with particle variable energy are represented. The proton energy may change over range of 7.5 to 100-Mev. It is also possible to accelerate multicharged ions. A brief description of the major parts of the cyclotron is given. (auth)

11949 THE KAZAKHSTAN 1.5 m CYCLOTRON WITH SECTOR FOCUSING AND CONTROLLED ENERGY. A. A. Arsumanov, E. A. Meleshko, R. A. Meshcherov, and L. M. Nemenov (Inst. of Nuclear Physics, Academy of Sciences, Kazan SSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 604-7(1964). (In Russian)

The results of experiments made on the 1.5 m cyclotron are briefly summarized. General evidence about the cyclotron is reported as well as its reconstruction into a cyclotron with sector focusing and controlled energy. There are three sectors with small spirality and a single dee. The ion energy obtained is: 5–40 Mev for protons, 10–32 Mev for deuterons, and up to 64 Mev for alpha particles. The ejected beam current is 50–100 mamp. The dee potential with respect to ground is 100 kv. The beam ejection is performed by combining the electrostatic system with the magnetic channel. (auth)

11950 EFFECT OF FREE OSCILLATIONS ON THE PARTICLE REVOLUTION PERIOD IN A RELATIVISTIC CYCLOTRON. V. P. Dmitrievskii, B. I. Zamolodchikov, V. V. Kolga, and T. M. Prilipko (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 608-10(1964). (In Russian)

A variation of the revolution period of particles accelerated in a relativistic cyclotron due to the presence of free particle oscillations about the equilibrium orbit was investigated. It was shown that there are no inaccuracies in performing the topography of the average magnetic field and the possible number of revolutions in a relativistic cyclotron is limited and depends upon the amplitude range of free oscillations, while the main effect is due to radial oscillations. By approximately solving the nonlinear equations describing free oscillations an analytic dependence of the particle revolution period upon the amplitude of free oscillations was found in the space-inhomogeneous magnetic field. With some parameters the values of the particle revolution period were calculated by direct integrating on a computer. These calculations show that the accuracy of analytical solutions is satisfactory. A formula is given which describes necessary accelerating voltage under various suppositions concerning the amplitude distribution of free oscillations. Numerical calculations of this effect for a 700-Mev relativistic proton cyclotron were made. (auth)

11951 AUTOMATIC CONTROL OF THE PHASE OF A BUNCH IN AN ISOCHRONOUS CYCLOTRON. A. M. Gris and A. A. Kuzmin (Radiotechnical Inst., Moscow). Tr.

Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 616-19 (1964). (In Russian)

A description is given of the magnetic field automatic control in an isochronous cyclotron. Information on the phase position of the bunch inside the D-shaped electrode is obtained by measuring the phase difference between the signal induced by the bunch on the pick-up electrode and the accelerating voltage. (auth)

11952 OPERATION OF SYMMETRICAL ELECTRON RING PHASOTRON OF THE LEBEDEV PHYSICAL INSTITUTE OF THE USSR ACADEMY OF SCIENCES. V. N. Kanunnikov, A. A. Kolomenskii, E. P. Ovchinnikov, E. F. Troyanov, A. P. Fateev, and B. N. Yablokov (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 653-7(1964). (In Russian)

Work performed in putting into operation the symmetrical ring phasotron of the Lebedev Physical Institute is reported. Work on the magnet system, power supply, injection, and acceleration is described. Magnet measurements and methods of correcting and stabilizing the magnetic field also are described. The results of measurements on the characteristics of the electron beam during the initial stage of acceleration are reported. (auth)

11953 THE LOW INJECTION INTO THE CYCLOTRON. V. A. Gradyshev, L. N. Katsaurov, A. N. Kuznetsov, L. P. Martynova, and E. M. Moroz (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 658-61(1964). (In Russian)

The external ion injection into the median plane of the three-sector radial ridge cyclotron was investigated experimentally. The beam focusing along the way to the accelerating gap was found to be strong enough and the losses of the beam were negligible. (auth)

11954 SECTOR FOCUSED CYCLOTRON AT THE UNIVERSITY OF MILAN. E. Acerbi, M. Castiglioni, M. Fois, A. Luccio, F. Resmini, C. Succi, and G. Tagliaferri (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 662-6(1964).

Construction of a 45-Mev proton cyclotron is nearing completion. This accelerator is of the AVF type; the azimuthal modulation of the magnetic field is produced by three pairs of 60° sectors with straight edges. The pole diameter is 166 cm, so that given the generous ratings of magnet winding and d-c power supply a magnetic rigidity adequate for 60-Mev protons might be eventually reached. The notable feature of the poletip geometry is the effort to minimize the need for correction coils, in order to simplify the engineering design and reduce power consumption. The poletips are actually contoured to produce a field within 0.3% of the values required for isochronous acceleration; fine corrections are provided by 8 pairs of circular trimming coils located outside the vacuum tank. The total (magnet + trimming coils) power needed for cyclotron operation will not exceed 150 kw. The major components of the accelerator and most of its ancillary equipment were built and assembled, and are presently being tested. (auth)

11955 THE FAST EJECTION SYSTEM OF THE CERN 25 Gev PROTON SYNCHROTRON. R. Bertolotto, H. van Breugel, L. Caris, et al. (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 669-89(1964).

The design, construction, and tests of the fast ejection equipment are discussed, and the results of early experience in ejecting the proton beam are given. (auth)

11956 THE CPS RESONANT EXTRACTION SYSTEM. H. G. Hereward (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 690-2(1964).

The slow extraction project for the CERN Proton Synchrotron will use the resonant buildup of betatron oscillations at the $Q_r = 6$ stop-band, excited by means of the quadrupole and sextupole lenses of the machine. Theory indicates that it should be possible to extract the beam reasonably uniformly over periods of the order of 100 msec, with high efficiency and good optical properties in the external beam. Preliminary experiments on the resonant spill-out process are in good agreement with the theory and confirm that a useful slow extraction system can be based on it. (auth)

11957 USE OF HALF-INTEGRAL RESONANCE IN 10 Gev PROTON-SYNCHROTRON FOR THE EXTRACTION OF PARTICLES. L. P. Zinovev, I. B. Issinskii, V. I. Kotov, E. M. Kulakova, K. P. Myznikov, and N. I. Pavlov (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 693-7(1964). (In Russian)

The artificial excitation of a half-integral resonance that can be applied to make accelerated particles come rapidly onto the target and to eject the beam from weak-focusing proton synchrotron is investigated. A theoretical analysis was made of the motion of particles by the half-integral resonance under the real conditions of the JINR proton synchrotron. The calculations showed that the resonance conditions in the useful region may be created by means of excitation of the two neighboring magnet sectors of an additional magnetic field increasing in time and providing the change of the fall-off index by a value 0.2 during 400 revolutions of particles. On the basis of the experiments made on the magnet proton synchrotron model one has chosen the simplest arrangement of the wires on the magnet poles inside the vacuum chamber that allowed one to get a necessary additional field. The current in the wires is obtained by charging a condenser bank to 10,000 volts, and then discharging the condenser through the wires by means of thyratron. The system has an inductance of 3 mH and a capacitance of 10 μF, a peak current of 400 amp at 10 kv. This system was used for obtaining a rapid knock out of the accelerated beam onto the target and allowed one to get the pulses of secondary particles with duration up to 30 msec instead of the usual 4.5 msec. The dependences of the length of the time that beam strikes the target and the radial beam spread of protons on the target on the value of the perturbation were obtained for various radial positrons of the target with respect to the equilibrium orbit. A possibility of using this method for the extraction of the primary proton beam for the accelerator chamber is discussed. (auth)

11958 EXPERIMENTAL BUILDINGS AND BEAM LAYOUT FOR A 300-Gev PROTON SYNCHROTRON. B. de Raad (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 730-7(1964).

The design of experimental areas for a 300-Bev proton synchrotron is heavily influenced by the extreme forward collimation of secondaries, the enormous amounts of shielding required to stop muons, and the need for a flexible layout which can accommodate entirely new experiments that cannot be foreseen at present. Theoretical predictions and the first results with the external beam from the CERN proton synchrotron indicate that efficient extraction and good external beam quality can be obtained. To satisfy the requirements listed above it is proposed to use only external targets. This will also simplify the construction of the ring tunnel and eliminate machine shutdowns for the purpose of changing secondary beams. (auth)

11959 DESIGN STATUS OF BEAM SWITCHYARD AND EXPERIMENTAL AREAS OF THE STANFORD TWO-MILE LINEAR ACCELERATOR. R. E. Taylor (Stanford Univ., Calif.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 738-41(1964).

The optics of the beam transport system and problems arising from the necessity of handling large amounts of power are discussed. Plans for the use of various beams and the associated experimental areas are reviewed. (auth)

11960 ON THE BEAM EXTRACTION FROM ISOCHRONOUS CYCLOTRON. Yu. G. Basargin (Scientific-Research Inst. of Electrophysical Apparatuses, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 742-4 (1964). (In Russian)

Theoretical results on the transmission of protons across the electrostatic deflector of the 2.4-m cyclotron are presented. The results indicate that it is possible to extract 100-Mev protons with high efficiency. Two variations for extracting beams by slowing down particles in foils were also discussed. (C.E.S.)

11961 TARGET EFFICIENCY CALCULATIONS. J. A. Geibel, J. Ranft, and W. Richter (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 759-66 (1964).

Efficiency for multitraversal targets in a proton synchrotron may be defined as the number of protons which make nuclear interactions (including diffraction scattering) in the target, against the total number of accelerated protons. A computer program was written to calculate this efficiency and the burst shape for the targets used in the CPS. It takes into account the material, shape, and size of the target and its support, as well as the machine energy, the size of the accelerated beam, and the vacuum chamber (between the stop bands). For some 40 to 100 protons the actual or the probable path inside the machine is calculated by using random-numbers for the effective Coulomb scattering at any given target traversal. Since measurements for the absolute target efficiency are not yet available, the results of the calculation for different target positions and for different sweeping of the beam across very small targets were compared with measurements. There was good agreement in change of efficiency, burst shape, and remaining fraction of the beam. (auth)

11962 EXTENSION OF THE USE OF ELECTROSTATIC SEPARATORS IN HIGH ENERGIES. C. Germain (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 775-8(1964).

Existing or shortly projected high energy separated beams are briefly surveyed and the factors limiting the use of electrostatic separators in high energies are examined. A summary of the tests made at CERN on their behavior is reported, and from these a possible extrapolation is made of the use of electrostatic separators at high energies. (auth)

11963 PARTICLE SEPARATORS AT ARGONNE NATIONAL LABORATORY. M. L. Good, D. L. Hillis, E. M. Lyman, and J. Terandy (Univ. of Wisconsin, Madison). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 779-81 (1964).

Conventional, but high-precision parallel-plate electrostatic particle separators are under construction. One hundred twenty feet (36m) of separator will be built, in 3 and 6m lengths. Stainless steel electrodes are planned, although glass cathodes can be incorporated. Electric and magnetic fields uniform to ±.05% are expected. In beams with sextupole and octupole connection coils, separation of up to 5 Bev/c K's should be possible. (auth)

11964 A HIGH MOMENTUM SEPARATED PARTICLE BEAM FOR USE WITH THE 1.50 m BRITISH NATIONAL HYDROGEN BUBBLE CHAMBER AT CERN. E. Keil (CERN, [Geneva]) and W. W. Neale. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 782-7(1964).

A beam is being constructed in the East Experimental Area of the CERN Proton Synchrotron (P.S.) which should provide the 1.50 meter British National Hydrogen Bubble Chamber with a selection of reasonably pure beams of kaons, pions, protons, and antiprotons with momenta up to about 15 Bev/c. The beam, of length 180 meters, combines in a single channel an electrostatically separated (E.S.) beam which used 30 meters of separator in a single separation state, and a radiofrequency separated beam using two travelling wave transverse deflecting cavities. A brief description of both beams and an estimate of their performance is given. Special features of the two beams include: targets inside a P.S. magnet unit to provide low production angles for negative particles, remotely adjustable collimators, and in the E.S. beam a new system of track labeling for the bubble chamber, based on a pulsed bending magnet and Cherenkov and scintillation counters. (auth)

11965 ELECTRODYNAMIC SEPARATOR OF ANTIPROTONS WITH THE MOMENTUM 5 Gev/c. V. A. Vagin, V. I. Veksler, V. N. Zubarev, et al. (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 788-90(1964). (In Russian)

The electrodynamic separator of antiprotons with the momentum of 5 Bev/c is described. Its main parameters are given. The electrodynamic separator consists of the r-f system which provides the proper particle beam structure (a system of acceleration on a high harmonic). This system operates on the frequency of 150 MHz and recaptures high energy protons to the regime of acceleration on a 100-th harmonic. The total r-f voltage on the gap of resonators is 200 kv. The deflecting system operates on the same frequency for space separation of particles. The deflecting system consists of 16 cavities in which the r-f transverse electric field is formed. The total length of the electric path of the resonators is 800 cm. The strength of the electric field on the gap is 30–40 kv/cm. The optic system consists of three objectives of the quadrupole magnetic lenses. The analysis of the beam and the compensation of dispersion of the particle fractional momentum is achieved by means of two electromagnets. A special magnet amplifies space separation produced by cavities. (auth)

11966 DEFLECTING SYSTEM OF THE 5 Gev/c ANTIPROTON CHANNEL FOR THE DUBNA PROTON SYNCHROTRON. M. S. Davydov, L. G. Dorfman, V. B. Salmandon, et al. (Scientific-Research Inst. of Electrophysical Apparatuses, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 791-4(1964). (In Russian)

The basic design principles and some problems of adjusting and tuning the deflecting system and u-h-f oscillator of the 5 Bev antiproton channel for the Dubna proton synchrotron are described. The construction of such a channel was based on the principle of electrodynamic ultrahigh energy particle separation. (auth)

11967 EXPERIMENTAL INVESTIGATION OF THE PROTON ACCELERATION OF A HIGH HARMONICS (f = 69 MHz) IN THE 10 Gev SYNCHROPHASOTRON. V. A. Vagin, M. Vysotchanskii, S. V. Mukhin, S. V. Rikhvitskii, N. I. Semenyushkin, V. L. Stepanyuk, and I. Foltin (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 795-7(1964). (In Russian)

In order to check experimentally on the synchrophasotron the principle of the electrodynamic separator of antiprotons with the momentum 5 Bev/c, a system was constructed by means of which high-energy protons are recaptured at the constant frequency of 69 MHz and are bent to target. The dependence of the recapture coefficient upon the amplitude of the r-f voltage and other parameters of the system were investigated experimentally for the proton energies of 2.2, 3.5, and 10 Bev. The extraction of the beam to the target took place due to frequency constancy of the above system, and by means of a system of azimuthal asymmetry of the magnetic field. The measurement of the r-f beam structure was made with the aid of a multichannel fast coincidence circuit. Optimum conditions for the extraction from the accelerator of the secondary particle beam of the proper r-f structure were determined. (auth)

11968 RF PARTICLE SEPARATORS. M. Bell, P. Bramham, R. D. Fortune, E. Keil, and B. W. Montague (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 798-803(1964).

Radio frequency separators will spatially separate particles of different rest masses at much higher momenta than is possible with conventional electrostatic separators. Studies were made on the feasibility of r-f separation of beams from accelerators in the 150–300 Bev range. It appears that, with relatively modest improvements in techniques, separated beams up to 200 Bev/c should be possible. Recent advances in microwave superconductivity make a superconducting r-f separator appear feasible.

Such a separator, with continuous or long pulse operation, would be particularly attractive as a research tool for use with the next generation of accelerators. (auth)

11969 INVESTIGATIONS OF TRAVELING-WAVE SEPARATORS FOR THE STANFORD TWO-MILE LINEAR ACCELERATOR. R. R. Larsen, O. A. Altenmueller, and G. A. Loew (Stanford Univ., Calif.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 804-18(1964).

Theoretical and experimental results of an investigation of traveling-wave separators for the Stanford Two-Mile Linear Accelerator are presented. A theoretical discussion of the choice and optimization of traveling-wave structures capable of separating bunched beams of particles moving at different velocities is included. Two designed prototypes using disk-loaded waveguides operating at 2856 Mc were examined experimentally. Preliminary results obtained by using these prototypes to deflect a bunched electron beam emerging from the Stanford 100-Mev Mark IV accelerator are included with a description of the microwave drive system utilized in this experiment. (auth)

11970 ON THE FORMATION OF HIGH-ENERGY MUON BEAMS. N. A. Burgov and A. G. Beda (Inst. of Theoretical and Experimental Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 819-20 (1964). (In Russian)

A method of high-energy muon beam formation by means of the ironless magnetic system consisting of some parallel high current wires is considered. The equations of the particle motion in the system are derived. The efficiency of the system is evaluated by the Monte Carlo Method. The system is shown to keep a large part of muons produced in pion decays. The system design is considered, and its feasibility is shown. The experiments on the electron model of the system proves the correctness of the assumptions made. (auth)

11971 ON THE THEORY OF A CHANNEL CONSISTING OF MAGNETIC QUADRUPOLES FOR OBTAINING μ-MESON PURE BEAMS. N. K. Abrosimov, D. M. Kaminker, I. A. Petrov, and S. G. Sherman (Ioffe Inst. of Physics and Tech., Leningrad). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 821-5(1964). (In Russian)

The conditions of formation of a meson(μ) beam in a channel consisting of successive magnetic quadrupoles are considered. There are no assumptions about the small length of the lenses used, and the results are valid for lenses of arbitrary length. The stability of charged particle motion in the channel is investigated and the boundary of the stability region is determined. The phase regions of meson(μ) capture (obtained in the π meson decay inside the channel) into the beam are found in terms of envelopes, and an expression is obtained to determine the efficiency of the channel. (auth)

11972 SHIELDING MEASUREMENTS ON A 4-Gev PHOTON BEAM. James K. DePagter and Mircea Fotino (Massachusetts Inst. of Tech., Cambridge and Harvard Univ., Cambridge, Mass.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 826-9(1964).

Results are given for the angular and longitudinal distributions of radiation intensities transmitted through shielding walls in directions parallel and perpendicular to a collimated 4-Bev photon beam. The main exponential attenuation coefficients obtained for ilmenite-loaded concrete ($\rho = 4.0$) are: transverse (at $\theta = 70°$) – nucleonic shower: $\lambda = 2.1$/ft; (ii) longitudinal ($0 < \theta < 10°$) – nucleonic shower ($2 < t < 6$ ft) $\lambda_n = 1.5$/ft; muons ($t > 8$ ft) $\lambda_\mu = 0.35$/ft. Soft shower penetration is 6 ft. An attempt is made to analyze the nature of the radiation. (auth)

11973 NONLINEAR EFFECTS AND INTERNAL RESONANCES IN A RELATIVISTIC CYCLOTRON. V. P. Dmitrievskii, V. V. Kolga, and N. I. Polumordvinova (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 833-9(1964). (In Russian)

The presence of considerable nonlinear forces affecting the motion of accelerated particles is a characteristic feature of the relativistic cyclotron. The effect of nonlinear forces on free oscillation frequency of charged particles and the internal nonlinear resonances of free particle oscillations, excited by the main focusing harmonic of the spiral structure of the magnetic field were investigated. The analytic expression was found for describing the dependences of vertical oscillation frequency upon the oscillation amplitude the accuracy of which is confirmed directly by the calculation of this effect with the computer. It was shown that in the several hundred Mev relativistic cyclotron the nonlinear resonances of the third and the fourth orders give rise to the swing of radial oscillations which causes practically the complete loss of the accelerated beam. The nonlinear resonances of the fifth and higher orders can be crossed without any considerable loss of accelerated particles. The numerical calculations of nonlinear resonance regions and the process of dynamic passage through resonance zones were made with some parameters of the magnetic field. The values of the frequencies with various amplitudes of vertical oscillations were found. The nonlinear resonance effects for a 700-Mev relativistic cyclotron were calculated. (auth)

11974 EFFECTS OF FIELD PERTURBATIONS IN FFAG ACCELERATORS. G. Parzen and P. L. Morton (Midwestern Universities Research Assn., Madison, Wis.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 840-3 (1964).

Because of the variation of the betatron oscillation frequencies, ν_x and ν_z, with the amplitude of the oscillation, it is difficult to avoid the resonances excited by perturbing fields. The range of tuning, ν_r and ν_z, covered by a beam, which includes the useful range of oscillation amplitudes, will contain a large number of perturbation resonances that will affect the betatron oscillations of the particles. The rapid variation of tune with amplitude seems, however, to limit the effect of the perturbation resonances. Detailed results are given for the effects of the nearest linear coupling resonance, which is $\nu_r + \nu_z = 16$ for the accelerator considered, and which will be one of the stronger resonances excited by the perturbing magnetic fields. (auth)

11975 THE NON-LINEAR RESONANCE OF $\frac{2}{3}$ FREQUENCY IN A PROTON SYNCHROTRON. V. I. Kotov, A. B. Kuznetsov, and N. B. Rubin (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 844-6(1964). (In Russian)

In connection with works directed to the increase of the intensity of proton synchrotrons there arises a necessity for revealing different factors leading to the loss of particles. From this point of view it is interesting to consider the nonlinear resonance of the third order with $\frac{2}{3}$ frequency radial betatron oscillations which in ring accelerators with straight sections is found inside the usual useful region. In the JINR proton synchrotron it takes place for $n = 0.63$. This resonance is considered in detail. The main attention is paid to the investigation of the multiple passage of particles through the resonance in the process of the phase oscillations. The regularities and the character of the losses of particles are established. The obtained analytical expressions enable one to estimate the losses of particles in any weak-focusing proton synchrotron. In particular, it follows that under some conditions this resonance can give losses of the beam during acceleration which amount to 50% or more. (auth)

11976 EXAMPLE OF STOCHASTIC INSTABILITY OF NON-LINEAR OSCILLATIONS. B. V. Chirikov (Inst. of Nuclear Physics, Novosibersk, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 847-8(1964). (In Russian)

The example indicates that forced oscillations in nonlinear systems result in stochastic instability. This fact may be essential for new nonlinear accelerators. (auth)

11977 FEEDBACK NETWORKS FOR USE IN BEAM-CONTROLLED ACCELERATION IN SYNCHROTRONS.

J. R. Rees. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 849-54(1964).

Previous investigations of beam controlled acceleration are considered. Characteristics of the beam motion suggest certain feedback networks, and these characteristics are outlined. (C.E.S.)

11978 A CYCLE ACCELERATOR WITH SUPERSTRONG FOCUSING AND ADJUSTMENT OF THE FIRST TURN USING A HEAVY ION BEAM. A. A. Vasilev (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 855-9(1964). (In Russian)

The utilization of additional lenses for focusing the particles enables an accelerating cycle scheme to be constructed having a variable number of betatron oscillations per turn during the cycle and, consequently, a very large transverse focusing force during the first stage of acceleration. The possibility of realizing such superstrong focusing is studied for a 1000-Bev proton accelerator. The use of an automatic control system for the guide field for adjustment of the first turn based on the utilization of heavy ions and increase of the focusing strength during the first stage of acceleration enable a 1000-Bev accelerator to be constructed whose vacuum chamber has a small aperture; injection into this chamber is accomplished right from a linear accelerator having an energy of about 100-Mev. (auth)

11979 ON THE EFFECT OF ABRUPT CHANGE OF THE FOCUSING FORCE ON PARTICLE DYNAMICS IN ACCELERATOR. E. L. Burshtein (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 860-2(1964). (In Russian)

Betatron and synchrotron oscillations are investigated in an alternating-gradient accelerator for an instantaneous jump in the number of betatron oscillations Q per revolution (the use of this jump in Q enables the accelerator aperture to be reduced). The crossing of resonances during non-instantaneous variation of Q is considered. (auth)

11980 A METHOD FOR CONSEQUENT CORRECTIONS OF THE FIELD DURING THE FIRST TURN IN CYBERNETIC ACCELERATOR. E. L. Burshtein (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 863-6(1964). (In Russian)

A calculation is made of the root-mean-square deviation of a particle from its equilibrium orbit due to random disturbances in the guide magnetic field. From the value of this deviation the number of probe injections is found, which are necessary for adjustment of the first turn. A numerical calculation is carried out for a definite focusing system. (auth)

11981 ANALYSIS OF THE AUTOMATIC CONTROL SYSTEM FOR THE FIRST TURN USING HEAVY IONS. A. I. Dzergatch and V. A. Karpov (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 867-70(1964). (In Russian)

The feasibility of a system correcting for random disturbances in the motion of a bunch of particles in an alternating-gradient synchrotron during the first turn after injection is discussed. The required number of measuring and correcting devices for a 1000-Bev accelerator as a function of the values of the magnetic field tolerances is determined from an analysis of the smoothed motion equation. Different layouts for the measuring and correcting elements, and also the requirements imposed on them are considered. It is shown that the system of automatic correction of the first turn with heavy ions permits protons to be injected at energies of about 100-Mev. (auth)

11982 AUTOMATIC CONTROL OF THE CLOSED ORBIT. A. A. Vasilev (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 871-3 (1964). (In Russian)

It is shown that a system can be created for automatic control of the closed orbit in an accelerator having an energy of several hundred Bev, which would greatly reduce the aperture of the vacuum chamber and simplify the design of the electromagnet. Concerning the possible parameters of an accelerator the realization of a system based on an harmonic analysis is considered. Questions connected with the separation of forced and free betatron oscillations are discussed. (auth)

11983 AUTOMATIC CONTROL OF HARMONICS IN THE MAGNETIC FIELD GRADIENT DETERMINING THE STOPBANDS. A. I. Dzergatch and N. L. Sosenskii (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 874-7(1964). (In Russian)

The exceedingly stringent tolerances on the spread of the field index n from magnet to magnet in extra-high energy accelerators is stipulated by the width of the integral and half-integral stopbands. A control system for the magnetic field gradient that utilizes information on the amplitude and phase of two harmonics in the parametric oscillations of the bunch is described. In accordance with this information compensation is carried out on two space harmonics in a magnetic field gradient whose presence causes the stopbands to exist. The use of such a control system in an extra-high-energy accelerator enables the tolerances on the spread of n from magnet to magnet to be substantially reduced. (auth)

11984 AUTOMATIC CONTROL OF THE FREQUENCY OF BETATRON OSCILLATIONS IN A STRONG FOCUSING ACCELERATOR. N. L. Sosenskii (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 878-81(1964). (In Russian)

A harmonic analysis is carried out of the voltage on the pick-up electrodes induced by betatron oscillations of the center of the bunch. The question of how the excitation of oscillations of the center of the bunch affects its cross section is studied. One possible block diagram for the control system is considered. The fundamental relations describing its operation are presented, and a method is given for designing such a system. (auth)

11985 ON AUTOMATIC SYSTEMS FOR CORRECTING THE RF VOLTAGE AND THE RATE OF INCREASE OF MAGNETIC FIELD IN CYCLIC ACCELERATOR. V. A. Bertulis (Tomsk State Univ., USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 886-90(1964). (In Russian)

A harmonic linearization method permitting one to study a fluctuation process taking into consideration both the transfer coefficient and the dynamic properties of the automatic system for correcting accelerating tension is suggested. A static linearization principle is used for taking into account accidental external influences. A principle of construction of an external regulator that permits one to regulate the time in order to decrease losses of radiation energy without losses of bunch particles is presented. A kind of program for producing a signal which regulates the speed of growth of the magnetic field is defined by means of harmonic linearization of nonlinear operation. It is possible to obtain sufficiently exact calculation results of the accelerator parameters by means of the universal modeling machine. (auth)

11986 ON THE DETERMINATION OF THE MAGNETIC FIELD DISTRIBUTION AND OF THE POLE FACE SHAPE FOR A 10^{12} ev PROTON SYNCHROTRON. C. C. Iliescu (Inst. for Atomic Physics, Budapest). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 891-6(1964).

An analytical method is outlined for the computation of the magnetic field distribution in the air gap of particle accelerators and of the pole face shape required for generating this distribution characterized by the field index. The concept of an ideal pole face, which has an infinite radial extension, is made out of a magnetic material of infinite permeability, and which lacks remanence and saturation is used. The method is applied to a 10^{12}-ev proton synchrotron. (C.E.S.)

11987 OSCILLATIONS IN A SYNCHROTRON UNDER SPACE CHARGE CONDITIONS. P. Lapostolle (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 900-5(1964).

A computation is made of the betatron oscillations within a cylindrical or scalloping beam with intense space charge in a strong focusing synchrotron. This analysis, which neglects the fine mesh structure of the motion, shows that the betatron wavelengths depend on the scalloping factor: the wavelength is always smaller than it is with a cylindrical beam. From this property, one can expect that it is possible to cross the n type resonances during acceleration. Since the F-type resonances due to space charge are nonexistent, it is hoped that the space charge limit in strong focusing synchrotrons is much higher than indicated by present theories. (auth)

11988 THE ACCELERATION OF POLARIZED PARTICLES IN A SYNCHROTRON. Kh. A. Simonyan (Inst. of Physics, Erevan). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 915-18(1964). (In Russian)

General formulas for changing the orientation of the spin of the accelerated particle (primarily directed along the magnetic field) after the passage of the resonances are obtained. The action of different resonances (in the proton and electron accelerators) which the particle encountered during the acceleration process are analyzed. (auth)

11989 RESONANCE DEPOLARIZATION OF PROTON BEAM IN THE ITEP PROTON SYNCHROTRONS. P. R. Zenkevich (Inst. of Theoretical and Experimental Physics, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 919-20(1964). (In Russian)

The possibility of acceleration of polarized protons in the 7- and 70-Bev ITEP proton synchrotrons is investigated, and the results obtained are given. Polarization degree is estimated by the recently developed method of the approximate solution of the classical relativistic equation for the polarization vector. A strong resonance depolarization of the beam proved to exist in the ITEP PS's influenced by the radial component of the magnetic field, arising due to some incorrections in the magnetic system. (auth)

11990 ON THE SPIN AND POLARIZATION EFFECTS IN THE THEORY OF SYNCHROTRON RADIATION. A. A. Sokolov and I. M. Ternov (Moscow State Univ.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 921-3(1964). (In Russian)

The influence of the polarized synchrotron radiation on the behavior of the electron spin is investigated. Both the possibilities of the longitudinal spin direction (along the path of the motion) and direction along the field are studied. In the first case it seems most convenient to characterize the spin by the polarization pseudovector $T_{\mu 4} = \frac{1}{2}\{\pi_4\sigma_\mu + \sigma_\mu\pi_4\}$, where $\sigma_\mu = \{\vec{\sigma}, i\rho_1\}$ are the Dirac matrices, $\pi_i = i/c\{\vec{\mathfrak{K}} - e\varphi\}$ (e = e_0 in case of the electron). In the second case the spin direction is best characterized by the polarization tensor of the second rank: $\pi_{\mu\nu} = \int\psi^+ F_{\mu\nu 4}\psi d^3x$, $F_{\mu\nu\lambda} = c/2\{\pi_x\alpha_{\mu\nu} + \alpha_{\mu\nu}\pi_\lambda\}$ where $\alpha_{23} = \rho_3\sigma_1, \alpha_{14} = i\rho_2\sigma_1$ etc. In the longitudinal case it was shown that the spin flip probability due to the radiation effects is proportional to $\hbar^2$. (auth)

11991 AN RF SYSTEM FOR A 300 Gev PROTON SYNCHROTRON WITH MECHANICALLY TUNED CAVITIES. W. Schnell (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 927-31(1964).

In order to produce the large accelerating voltage required for a 300-Bev proton synchrotron it is proposed to use accelerating cavities that are tuned by means of a fast mechanical servo system. Model measurements, which were carried out with this type of cavity, are described, and the choice of parameters for the complete radio frequency system is discussed. If the injector for the 300-Bev machine is a fast cycling booster synchrotron, it is believed to be both possible and advantageous to employ the same type of mechanically tuned cavity for the booster as well as for the large machine, in spite of the much larger frequency swing that has to be covered by the booster r-f system. Model measurements were also done with respect to this application, and parameters for booster r-f systems are presented for a few typical cases. (auth)

11992 THE 70-Gev PROTON SYNCHROTRON ACCELERATING SYSTEM. F. A. Vodonyanov, L. S. Zhukovskii, V. B. Zalmanson, Yu. S. Ivanov, E. V. Izergina, A. A. Kuzmin, A. I. Prokopev, S. M. Rubchinskii, and A. S. Temkin (Radiotechnical Inst., Moscow). Tr. Mezhdunar, Konf. po Uskoritelyam, Dubna, 1963, 932-6(1964). (In Russian)

A brief description is given of the master oscillator, the power amplifier, and the accelerating device. Schematic solutions for the elements and characteristics of the system are presented. (auth)

11993 A MULTIPLEX CARRIER SYSTEM FOR REMOTE CONTROL IN LARGE ACCELERATORS. G. Brianti and B. Sagnell (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 937-40(1964).

The size of future accelerators extends the average cable length for remote control in the range of distances for which multiplex techniques become more economical than the normal direct-wire ones. This may be further enhanced since the total amount of remote control cables for an accelerator may well increase more quickly than in linear proportion with the radius because of the increased amount of equipment to be controlled. The case of simple control and interlock functions (ON/OFF) and of slowly varying signals (analog) which generally occupy together about 90% of the multicore cable capacity was studied. The time to install such facilities can be shortened, and the cost of providing medium-distance communication paths reduced, by the introduction of well-known carrier signalling techniques and modern components. As experimental communications system employing such techniques and components was developed. (auth)

11994 DESIGN OF A PROTON SYNCHROTRON BEAM CONTROL FREQUENCY SYSTEM. A. A. Kuzmin (Radiotechnical Inst., Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 941-5(1964). (In Russian)

A method is described for designing the beam control frequency system. In analyzing the stability of this system the properties of the beam and also the characteristics of real elements in the control circuit are taken into account. Requirements for the elements in the control circuit and tolerances for the electronic equipment of the beam controlled frequency system for a 7-Bev accelerator is presented. (auth)

11995 RADIO-FREQUENCY SYSTEM OF A 700 Mev CYCLOTRON. A. A. Glazov, V. A. Kochkin, L. M. Onishchenko, I. M. Roife, M. M. Semenov, E. Shvabe, and I. B. Tuzov (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 946-9 (1964). (In Russian)

The problems of selection, calculation, and modeling of the h-f system of a 700-Mev cyclotron are considered. The peculiarity of the accelerator is its very narrow pole gap with large diameter pole faces. This does not permit one to use a conventional cyclotron scheme when dee lines have the same direction (the pole diameter is longer than a quarter of the wavelength). The chosen scheme consists of two dees of a rectangular form smoothly continuing to coaxial resonance lines of the same form. The gap between the dee and the chamber cladding is profiled according to the pole profile, while outside the magnet it is immediately increased up to a considerable magnitude (20–25 cm). Thus, the tuning to a quarter-wave resonance is made when the length of the dee resonance system is shorter than a quarter-wave-length and the required freedom for spacing the coupling loop is achieved. The calculation and modeling show that such a system provides minimum power of losses. The full scale model was made for the final determination of the geometry sizes of the system, the power of losses, and the choice of the coupling system. The results of investigating its characteristics are reported. (auth)

11996 RESONANCE DISCHARGE IN ACCELERATORS. B. A. Zager and V. G. Tishin (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 953-7(1964). (In Russian)

The results of investigation of the effect of the resonance

r-f discharge (multipactoring effect) on the excitation of accelerating voltages in the vacuum cavities of accelerators are reported. The effect of the discharge resistivity on the quality factor of the volume cavities is treated. In studying the voltage excitation it is common practice to consider generators with independent excitation and self-oscillating systems. It is shown that when the cavity is supplied from a circuit with independent excitation the capacity of the generator given to the cavity should exceed a certain value characteristic of the given type of a cavity and of the discharge resistance. In self-oscillating systems the appearance of the resonance discharge leads to an unstable limiting cycle which opposes the excitation of large accelerating voltages. The generator may be normally excited by forming the initial conditions exceeding the value of unstable limiting cycle. A method of suppressing the resonance discharge by a constant displacement is investigated and the dependencies are given which allow one to calculate the needed magnitude of the constant displacemnet voltage. The results obtained are confirmed by experimental measurements performed with the 3 and 1.5 meter cyclotrons of the Joint Institute for Nuclear Research. (auth)

11997 SELECTION OF OPTIMUM PARAMETER INSTRUMENTS FOR MEASURING THE CURRENT AND THE POSITION OF PASSING PULSED PARTICLE BEAM. N. I. Mocheshnikov (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 965-9(1964). (In Russian)

Basic relations are derived for determining the shape and the value of the output pulse depending on the detecting element core parameters. The effect of the switch-on scheme and the windings parameters on the detecting element sensitivity is considered. The influence of current pulse shape on the detecting element sensitivity is considered, and a method for decreasing measurement errors is presented. The construction of the beam position detecting element used in the 2-Bev accelerator is described. (auth)

11998 SOME FEATURES OF TUNING THE ACCELERATION OF 10 Gev SYNCHROPHASOTRON. G. S. Kazanskii, A. B. Kuznetsov, A. I. Mikhailov, N. B. Rubin, A. P. Tsarenkov, and K. V. Chekhlov (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 970-5(1964). (In Russian)

In tuning the optimal acceleration regime it is necessary to have the data on the dynamics of processes occurring with a beam of injected protons both in the first and in the second injection regime. As far as the extraction of the information on the accelerated particle beam is concerned, the first injection regime is the most complicated one. In the quasi-betatron regime one needs the data on the structure of a continuous ring bunch of injected protons (the azimuthal of the charge inhomogeneities, etc) and on the oscillating processes which take place in the beam of injected particles. The results of investigation of the quasi-betatron regime by means of the electrostatic induction electrodes are reported. Some considerations are given on the nature of the structural changes in the beam of charged particles in the first injection regime and the connection of these changes with the subsequent acceptance of particles into the synchrotron regime. Methods of cultivating the r-f signals in the quasi-betatron regime are described and the utilization of this information in tuning the injection regime is pointed out. Data are on the development of a dynamic control system of the variation in the phase size of a bunch of accelerated particles. A technique is described of measuring the radial-phase oscillation frequencies and the monoenergetic beam of accelerated particles accepted. The data on the operation of systems for suppressing the resonance perturbations in the accelerated beam are given, and the instrument which allows one to measure the noise deviation of the r-f accelerating voltage in the dynamic regime is described. A method for suppressing the noise perturbations of the resonance frequency is reported. Some features of tuning the regimes in the interaction of the particle beam with a target are discussed (in particular, some methods of intensity stabilization, a quick interaction of the primary beam with target, etc.). Some original features of programming the regimes of physical experiments are briefly reported. Acceleration at the third harmonic is also discussed. (auth)

11999 PARTICLE LOSSES IN CROSSING NON-LINEAR RESONANCES: EXPERIMENTAL RESULTS WITH THE CERN ELECTRON CLOUD ANALOGUE MODEL. M. Barbier (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 976-82(1964). (In Russian)

An analog model using an electron cloud imprisoned in a cage of the Penning gauge type was build for the study of nonlinear oscillations of a bunch of particles. Experimental results are given for crossing a nonlinear resonance with a sinusoidal perturbation of the first, second, and third order, and also for a perturbation of the first order given by white noise. Experimental results are also presented for repeated crossing with drift through a nonlinear resonance for a sinusoidal perturbation of the first order. These results apply to a group of particles and represent the beam losses caused by such perturbations in accelerators. (auth)

12000 METHODS OF THE MEASUREMENT AND STABILIZATION OF THE TOPOGRAPHY OF RELATIVISTIC CYCLOTRON INHOMOGENEOUS FIELDS. D. P. Vasilevskaya, L. V. Vasilev, Yu. N. Denisov, N. I. Dyakov, S. A. Ivashkevich, V. V. Kalinichenko, V. V. Lachinov, V. I. Prilipko, Yu. I. Susov, and P. T. Shishlyannikov (Joint Inst. for Nuclear Research, Dubna, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 983-7(1964). (In Russian)

The results of investigating the measurement methods of the inhomogeneous magnetic fields of relativistic cyclotrons are reported. Magnetometers developed with this aim, based on the nuclear magnetic resonance and the Hall effect are described. The nuclear magnetometer allows to measure the strength of the magnetic field from 3000 to 22000 Oe with the gradient up to 4000 Oe/cm, to an accuracy of 0.01%. The inhomogeneity of the measured magnetic field in the sample cross section is compensated by additional magnetic field with the gradient of opposite direction. The intensity of the magnetic field corresponding to the sample center remains constant. The choice of optimum construction of the current quadrupole is considered. The results of measurements are typed on a paper tape directly in the units of the magnetic field. In the Hall magnetometer the probes of InPSb with the temperature coefficient of 0.2% degree C and the sensitivity of 3-5 v/Oe were used. The probes are $2 \times 1 \times 0.15$ mm^3. The accuracy of measuring the magnetic field with this instrument is 0.03%. The magnetic field is stabilized with nuclear stabilizers to an accuracy of 2×10^{-5}. (auth)

12001 ATOMIC BEAM SOURCE OF POLARIZED ELECTRONS FOR HIGH ENERGY ACCELERATORS. V. W. Hughes, R. L. Long, and W. Raith (Yale Univ., New Haven). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 988-92(1964).

An apparatus was built to produce polarized electrons suitable for injection into a high energy accelerator. The method involves photoionization of a beam of polarized alkali atoms and was proved to be successful by H. Friedmann. An intense beam of potassium atoms from an oven is deflected in a six pole inhomogeneous magnetic field so as to give a beam of atoms in the $m_j = +\frac{1}{2}$ magnetic substates (m_j = electron magnetic quantum number). This polarized atomic beam enters the photoionization region, which is at negative potential and is in a homogeneous axial magnetic field strong enough for decoupling the nuclear and electron spins. The resulting polarized electrons are extracted by an electrostatic field and accelerated to ground potential. The electron polarization is measured by Mott scattering after the longitudinal electron polarization is converted to transverse polarization. A current of greater than 10^{-8} ampere is expected, with a polarization between 80 and 90%. The status of the polarized electron source, possibilities for its pulsed operation, and the theory of depolarization during acceleration are discussed. (auth)

12002 CHARGE-EXCHANGE INJECTION OF PROTONS INTO CIRCULAR ACCELERATORS. G. I. Budker and G. I. Dimov (Inst. of Nuclear Physics, Novosibirsk, USSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 993-6 (1964). (In Russian)

The multiturn injection of protons into the ironless accelerator with intersecting beams on the accelerator orbit is presented. The main characteristics of injection are determined from the consideration of the effect of the charge-exchange target on a circulating beam. (auth)

12003 SOME CONSIDERATIONS OF NEUTRINO FACILITIES WITH LARGE ACCELERATORS. C. A. Ramm (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 997-1004(1964).

The conditions for the optimum neutrino flux, and intensity and energy distributions, from the two-body relativistic decay of parents are discussed as a function of parent energy. With accelerators of still higher energies the direct extrapolation of the present arrangements for neutrino experiments leads to unwieldy dimensions of shielding and detectors. It is concluded that a two stage parent focusing could be developed to control the neutrino spectrum and to obtain the maximum intensity. (auth)

12004 INDUCED RADIOACTIVITY IN ACCELERATORS. M. Barbier (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1005-11(1964).

The principal methods for studying induced radioactivity are presented. These include decay measurements and spectrographic analysis with counter telescopes pointed at various parts of active machines, examination of small samples irradiated in proton or neutron beams, experiments with thick samples to obtain the danger parameter, etc. Experimental data collected at the CERN synchrocyclotron are presented to illustrate the various methods of investigation. (auth)

12005 A H-TYPE MAGNET FOR A HIGH-ENERGY SYNCHROTRON. M. Barbier, G. Petrucci, E. Solinas, and A. Susini (CERN, [Geneva]). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1012-13(1964).

Until now, C-type magnets are currently in use for strong focusing synchrotrons. For very large synchrotrons, H-type magnets may become attractive, as they allow a substantial economy in overall dimensions and weight. The principal features of the H-type solution are analyzed, and a new method of assembly is presented. A numerical example for the case of a 300-Bev machine is treated, showing the values of the principal parameters which may be obtained with this construction. (auth)

12006 CHARGED PARTICLE ACCELERATION BY MEANS OF LONGITUDINAL WAVES IN PLASMA AND IN PLASMA WAVE GUIDES. A. K. Berezin, G. P. Berezina, L. I. Bolotin, et al. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1023-9(1964). (In Russian)

The use of plasma and plasma waveguides for accelerating electrons and ions for linear accelerators is analyzed. In these systems the electromagnetic waves propagating in the plasma are used to accelerate the particles. (C.E.S.)

12007 AUTORESONANCE ACCELERATION OF PARTICLES BY PLANE ELECTROMAGNETIC WAVE. A. A. Kolomenskii and A. N. Lebedev (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1030-5(1964). (In Russian)

The principle of resonance motion in a plane free electromagnetic wave obtained by superimposing a magnetic field and selecting special initial conditions is discussed. Resonance motion can be achieved at the wave frequency of 10^{13} cycles and a magnetic field of 10 to 100 Oe in a small volume. (C.E.S.)

12008 MEASUREMENTS ON A PLASMA BETATRON. J. Drees and W. Paul (Universität, Bonn). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1036-41(1964).

A plasma was produced by a high frequency electric quadrupole field (ν = 200 Megacycles) at gas pressures of 10^{-4} to 5×10^{-5} mm Hg in a quartz glass torus. The torus was placed between the poles of an air-core betatron with the following properties: radius of equilibrium orbit 20 cm, maximum accelerating field strength 80 v/cm, and energy 1.5 Mev. Associated with conduction currents of some 100 amp, energetic bremsstrahlung was observed and attributed to 1.2-Mev electrons. The number of accelerated electrons was of the order of 10^{11} per pulse. The intensity and energy of the radiation, together with the time dependence of the plasma current, were observed as a function of different parameters, such as the gas pressure, high-frequency amplitude, and induced acceleration field strength, for different gases. The energetic radiation disappears when, because of the self-induced magnetic filed, the stability condition for the betatron equilibrium is no longer fulfilled. (auth)

12009 PARTICLE MOTION IN THE PROPOSED BUDKER ACCELERATOR. L. J. Laslett (Iowa State Univ., Ames and Midwestern Universities Research Assn., Madison, Wis.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1042-8(1964).

Particle motion in the field of the proposed Budker accelerator, which employs a self-constricted relativistic beam, is analyzed, particularly for radial motion. Numerical results are given for proton motion in two examples of the Budker device. It is noted that, in these examples, the available stable phase area is more than sufficient at injection to accommodate an injected beam of emittance 10^{-3} cm radian at 50 Mev (kinetic energy), although this area results from the combination of a rather small range of coordinate values and a large permissible slope. It is also found, however, that the available stable area in radial phase space shrinks markedly as the proton rigidity increases and that this decrease will result in a loss of beam above a critical energy. The frequency of small-amplitude betatron oscillations (transverse oscillations per revolution) is seen to be very large (of the order of 10^3 or 10^4) at injection and to decrease markedly thereafter. The results of computational work are presented to suggest that the passage of the betatron frequency through many resonant values can result in a pronounced loss of beam during acceleration when only very small perturbations are present. (auth)

12010 THE HIGH-CURRENT MICROTRON. L. M. Zykin, S. P. Kapitza, V. N. Melekhin, and A. G. Nedelyaev (Inst. for Physical Problems, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1049-52(1964). (In Russian)

Until recently the microtron was not regarded as a promising accelerator because the intensities obtained were too low for any practical uses. New methods for raising the efficiency of the microtron were developed which now lead to new possibilities for this machine. The main features of the new microtron is the resonator, which consists of a plane cylindrical cavity with a comparatively large accelerating gap. By placing the electron emitter off the axis of the cavity the electrons may be accelerated in a number of ways in a wide range of energies and magnetic fields. The electrons are emitted directly by the high-frequency electric field from the heated surface of a lanthanum boride cathode. The magnetic field of the microtron is homogeneous and constant; the focusing of the beam is fully due to the electric field at the holes in the resonator, and by suitably shaping the entry and exit hole, stability both in the vertical and radial direction is obtained. The beam of electrons is bunched into compact bunches 5-8 mm in length, 3-5 mm in diameter ($\lambda \simeq 10$ cm). The extraction of the beam from the accelerator chamber does not present any difficulties as a magnetic channel shielding the beam is quite sufficient to guide the particles out of the machine without any appreciable loss (less than 10%). The first results with the new microtron were obtained on a machine with the magnetic pole diameter (diameter of the chamber) D = 700 mm. At 12 orbits the energy obtained in this accelerator was 7 to 12 Mev with pulse currents up to 30 mamp. The success of

this accelerator allowed us to build a slightly greater machine (D = 750 mm and 17 orbits) and finally a larger microtron D = 1100 mm with 30 orbits and design energy of 30 to 40 Mev. The large machine has successfully accelerated electrons to 26 orbits and currents up to 20 mamp. All these accelerators use high-power pulsed S-band (10 cm) magnetrons. The efficiency of such accelerators approaches ~20 or 25%. The highest current (100 mamp in a pulse) so far produced is considerably lower than the theoretical limit (1 to 10 amp) obtained by considering the coherent radiation of the bunched electron beam. The great simplicity and high efficiency of the microtron makes it a competitive accelerator in the medium energy range (up to 50 Mev). Because of the high quality of the beam it is advantageous to use the microtron as an injector for larger accelerators. If one compares the microtron with the linear electron accelerators, with which it has much in common, one comes to the conclusion that apart from the high energy limit of the microtron, the only advantage of the electron linear accelerator is the acceleration of high transient currents by energy storage in the waveguide. The microtron can only work in a steady state, and such transient operation does not seem feasible. On the other hand, the development of continuous-wave high power microwave generators makes it possible to build C–W microtrons. Such a machine will have much in common with the cyclotron, and should efficiently produce electrons at energies 10-30 Mev and a beam power of tens of kilowatts. (auth)

12011 PARTICLE DYNAMICS IN THE MICROTRON. V. N. Melekhin (Inst. for Physical Problems, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1053-5 (1964). (In Russian)

The electron cyclotron, the microtron, differs from other cyclic accelerators in a number of ways and the theory of this accelerator presents some special features. The accelerating field is high and consequently the gain in energy at each passage of the resonator gap is of the same order of magnitude as the electron mass. According to the rise in energy the number of high-frequency cycles per orbit also varies. The magnetic field is homogeneous and constant, so all the focusing forces are due only to the high-frequency accelerating field in the cavity. By suitably shaping the entry and exit holes in the resonator efficient focusing may be obtained both in the vertical and radial directions. The period of phase oscillations in the microtron takes 4-5 revolutions and under certain conditions a resonance may occur between the phase and radial motion with the subsequent buildup of oscillations and a corresponding loss of particles. The radial motion of the orbits at the resonator is aperiodic and in a homogeneous magnetic field the orbits gradually approach a stable position. During acceleration the radial dimensions and divergence of the beam are reduced. In an inhomogeneous field the orbits drift, and the focusing power of the resonator usually cannot fully restore the effect of such perturbations. In a microtron with 30 to 50 orbits (30–50 Mev) the achievement of a sufficiently homogeneous and stable magnetic field does not present any special difficulties. In analyzing the focusing properties of the resonator, matrices are used much in the same way as in studying alternating gradient systems. The efficient capture of electrons into accelerating phases is achieved in cavities of a new type. By using high speed computors to integrate the equations of motion it is possible to calculate the efficiency of capture and to obtain all the dimensions of the accelerator cavity. The experimental results so far obtained in the high-current microtron fully confirm the calculations and show that in the microtron electrons may be efficiently and stably accelerated in a wide range of energies and magnetic fields. (auth)

12012 HIGH-CURRENT MICROTRON-INJECTOR. K. A. Belovintsev, A. Ya. Belyak, S. B. Vorozhtsov, and P. A. Cherenkov (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1056-60 (1964). (In Russian)

The main elements and the operation of the microtron with 7 Mev energy are described. It is used for electron injection into a synchrotron. The results of measurements of electron angular distributions in a beam at the accelerator output are given. Particular attention is paid to the problem of increasing the microtron efficiency due to the introduction of a ferrite element into the waveguide of the accelerator and to the choice of special conditions of cathode operation. The calculations made on a computer gave a possibility of establishing a number of new regions of primary phases and the cathode place available for stable acceleration. The experimental results on electron injection from the microtron into the 280-Mev synchrotron are given. (auth)

12013 POSITRON-MICROTRON. K. A. Belovintsev and P. A. Cherenkov (Lebedev Inst. of Physics, Moscow). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1061-4 (1964). (In Russian)

A possibility of the microtron use for positron production and its further acceleration in considered. Calculations made on a computer permitted to determine regions of phases, angles, and positron energy at the output of a converter satisfying the conditions of capture into the microtron acceleration regime. Preliminary experiments performed on the microtron confirmed a great efficiency of the suggested method of obtaining of relativistic positron beams. On the basis of the calculations there was elaborated a project of the universal β–injector-microtron permitting to obtain two beams e^- and e^+ with the same energy from one acceleration device simultaneously. (auth)

12014 WORKS ON HIGH-CURRENT ELECTRON ACCELERATORS OF THE INSTITUTE OF NUCLEAR PHYSICS AT THE SIBERIAN DIVISION OF THE USSR ACADEMY OF SCIENCES. E. A. Abramyan, I. E. Bender, L. N. Bondarenko, et al. (Inst. of Nuclear Physics, Academy of Sciences, Siberian SSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1065-72(1964). (In Russian)

Work on the construction of high-current ring electron accelerators carried out since 1954 was reviewed. The available arrangements may be divided into two classes: Accelerators with spiral storage of electrons and accelerators with single-turn capture of injected electrons. Accelerators with spiral storage of electrons include pulsed betatron B-2 with circulating current up to 70 amp synchrotron B-2S–injector for an arrangement with colliding electron beams, and pulsed betatron B-3 supplying currents of several hundred amperes at an energy up to 50 Mev. Accelerators with single-turn capture of injected electrons include the 400-Mev ironless single-turn synchrotron BSB with pulsed current of several tens of amperes and the synchrotron B-3M with the energy and current of the same order but with considerably larger repetition frequency up to 12 Hz. (auth)

12015 HIGH-CURRENT ACCELERATORS WITH SINGLE-TURN INJECTION INTO SYNCHROTRON. Yu. A. Grits, D. V. Iremashvili, A. A. Naumov, G. N. Ostreiko, V. S. Panasyuk, A. P. Nyatnitskii, A. A. Chernov, L. I. Yudin, and G. I. Yasnov (Inst. of Nuclear Physics, Academy of Sciences, Siberian SSR). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1080-4(1964). (In Russian)

Two types of electron linacs with single-turn injection into the synchrotron are given. The accelerators are based on the method of using the r-f power accumulated for accelerating high currents in a short pulse. Pulse duration amounts to a part of the r-f voltage period. The electron guns are placed in the cavities which are components of resonant contour condenser. The guns contain lanthanum boride cathodes and can supply a 30 amp current. The accelerating voltage amplitude in the accelerator of the first type is 1.1 Mv, the current is 16 amp, the resonant frequency of the radiotechnical contour is 14.5 MHz. The same parameters of the accelerator of the second type are 1.8 Mv, 25 amp, 6.4 Mhz, respectively. (auth)

12016 CONCEPTS OF THE SEPARATED ORBIT CYCLOTRON. F. M. Russell and R. S. Livingston (Oak Ridge

National Lab., Tenn.). Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1085-8(1964).

The principle of operation and the basic characteristics of a new type of cyclic accelerator in which successive orbits are separated in space are reviewed. The dependence of machine parameters on particle energy is examined; the study indicated that in the region of relativistic energies the machine cost varies linearly with the maximum energy. The single-pass nature of the acceleration process makes it possible to extract beams at various energies, always with 100% extraction efficiency. Preliminary calculations are given for a typical 12.5-Bev machine with an arbitrarily chosen 10% duty cycle to provide 1 mamp of protons in an external time-averaged beam. At the same time another 1-mamp external beam can be provided at 7 Bev during the remaining portion of the duty cycle. (auth)

12017 PHYSICAL BASES FOR EXPERIMENTS ON COUNTERCURRENT ELECTRON-POSITRON BEAMS. A. A. Komar, E. M. Leikin, Yu. N. Metal'nikov, E. M. Moroz, and V. A. Petukhov. Tr. Fiz. Inst., Akad. Nauk SSSR, 22: 222-95(1964). (In Russian)

Various physical processes were studied by means of countercurrent electron-positron beams. The processes examined are divided into three groups: electromagnetic, strong, and weak interactions. Effects that are used for confirming or denying quantum electrodynamics to the order of 10^{-15} cm and various deviations from ordinary theory are discussed. A foundation is given for selecting the mean parameters for countercurrent beams and data are given on the geometry and energy of particle beams. It is shown that bremsstrahlung and single scattering on residual gas in a 5×10^{-10} mm Hg vacuum are the main mechanisms of particle energy losses in a storage ring. The problems related to the injection of electrons and positrons into the storage ring are considered and descriptions are given of a capture method using inflector magnets. (R.V.J.)

12018 REVIEW OF THE PROJECTS OF ACCELERATORS OF ENERGY MORE THAN 100 Bev. S. K. Esin. p.477-95 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Design criteria of accelerators are reviewed, with special consideration of the cost. The requirements of magnetic field volume and means used to reduce it are examined, by a discussion of the Brookhaven 300-1000 Bev accelerator. High injection energy is desirable; thus, in Bev accelerators the ratio of maximum energy to injection energy was found to assume low values from 30 to 50. At present only circular accelerators are capable of achieving injection energies higher than 100 Mev; their properties are compared to those of linacs. The selection of the accelerating frequency is dependent on the injection bunching frequency and must be designed for the broadest possible capture of the injected energy spectrum. The frequency must be also sufficiently high to make allowances for the spacing of the coils and for power and modulation. For circular systems, it was found best to keep the injector and accelerator frequencies identical, while for linear injectors the accelerator frequency should be equal to the frequency of one step of the injector. Design problems are also created by the low permissible tolerances for the magnetic fields and field changes with time, maintenance problems of residual radioactivity, and space limitations of the injected beam. Several accelerator projects are reviewed, including the Brookhaven proton synchrotron, the Bev CEA electron synchrotron, and the CERN 300-Bev proton synchrotron. Problems presented by the automatic correction of field and gradient are also reviewed. Superhard focusing is made possible by automatic control of betatron oscillation frequencies through monitoring of the beam parameters, providing d-c-feeding of the quadrupole magnets. (TTT)

12019 PROGRESS IN THE TECHNIQUE OF STORING OF COLLIDING BEAMS. S. A. Kheifets. p.496-507 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The feasibility of producing and confining crossed particle beams was demonstrated previously. The problem of storage devices is reviewed for particles of energies exceeding 500 Mev. For systems operating with electrons and positrons, the lifetime of low-density beams is determined by the inelastic scattering of the particles on the residual gas atoms in the chamber; this time is inversely proportional to pressure and depends on the charge of the gas atoms. High-vacuum techniques, magnetic injection, increased particle fluxes, and strongly focusing magnetic systems are discussed. Planned and existing devices are reviewed. (TTT)

12020 VAN DE GRAAFF ACCELERATORS FOR RADIATION RESEARCH AND APPLICATIONS. E. Alfred Burrill (High Voltage Engineering Co., Burlington, Mass.). p.85-127 of "Radiation Sources." New York, The Macmillan Company, 1964.

Uses of Van de Graaff accelerators as radiation sources are discussed. The design and history of the Van de Graaff accelerator are described. Voltage generation and insulation, particle production and acceleration, vacuum conditions, voltage measurement and control, beam intensity, pulsed-beam operation, beam utilization, control, and radiation outputs are considered. Operating characteristics are summarized. Installation space requirements, radiation protection, and operating costs are discussed. (M.C.G.)

12021 CYLINDRICAL ELECTROSTATIC GENERATORS. N. J. Felici. p.128-70 of "Radiation Sources." New York, The Macmillan Company, 1964.

Electrostatic generation of electric power is reviewed. Modern concepts of electrostatic generators and the physical structure and basic parameters of the cylinder generator are described. Coupling of cylinder generators and their excitation and control are discussed. The technology of cylinder generators is reviewed, and possible failures are considered. The existing design types and operating costs are discussed. (M.C.G.)

12022 RESONANT-TRANSFORMER ELECTRON-BEAM GENERATORS. W. F. Westendorp. p.171-96 of "Radiation Sources." New York, The Macmillan Company, 1964.

Electron-beam generators of the resonance transformer type are discussed. The transformer is described and diagrams are given. The steel tank, cooling system, gas insulation, electron-beam vacuum tube, electric circuits, and associated equipment are also described. The exposure technique is outlined and examples given. The economic aspects of electron beam radiation are discussed and a sample process calculation shown. (M.C.G.)

12023 POWER SOURCES FOR IRRADIATION PROCESSING. THE LINEAR ACCELERATOR. C. W. Miller (Associated Electrical Industries Ltd., Manchester, Eng.). p.197-219 of "Radiation Sources." New York, The Macmillan Company, 1964.

Use of the linear accelerator as a radiation source and principles of its design and operation are discussed. Various accelerator types are described and diagrams and pictures are shown. Costs of irradiation using linear accelerators are considered. (M.C.G.)

12024 ELEKTROFIZICHESKAYA APPARATURA. VYPUSK I. (Electrophysical Devices Collection of Articles. Vol. I). Moscow, Gosatomizdat, 1963. 202p.

Eighteen articles describing electron-optical and ion-optical systems for strong-focusing accelerators are included. Development of high-intensity ion and electron sources and magnet structures for isochronous cylotrons is described. Separate abstracts are prepared for thirteen articles of special interest. (R.V.J.)

For abstracts of individual papers see: 11858, 12025, 12026, 12027, 12028, 12029, 12030, 12031, 12032, 12033, 12034, 12035, and 12036.

12025 ACCELERATED BEAM SHIFTING ON AN INTRINSIC TARGET IN A STRONG-FOCUSING SYNCHROTRON. I. A. Shukeilo. p.3-8 of "Elektrofizicheskaya

Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

A scheme is suggested for radial particle shifting into the target by distorting the orbit equilibrium only in the target zone with the rest of the ring undisturbed. The scheme is achieved by azimuthal symmetric (in relation to the target) local disturbances induced by a special winding attached together with the main excitation winding to the magnet circuit on the synchrotron. In such a case the elements of the beam extraction system do not fill up the free space between the blocks. The interaction time between the beam and the target is controlled by adjusting the electric potential in the winding. The potential polarity determines the direction of radial beam shift. A diagram is given of the azimuthal position, the disturbance field, and disturbance orbit positions at various times. The particle beam shifts into the target with the orbit distortion approximately equal to the half-width of the vacuum chamber, and the corresponding disturbances are of the order of 10^{-2} H_0. (R.V.J.)

12026 MODIFICATION OF THE MAGNETIC STRUCTURE IN ISOCHRONOUS CYCLOTRON. Yu. G. Basargin. p.9-17 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

A modification is suggested for an isochronous cyclotron magnetic structure with radial-sector and spiral-sector properties. The modification increased the accelerated beam energy without adding power windings. The magnet parameters are adjusted for isochronous acceleration protons to 60 Mev in a two-meter cyclotron. (R.V.J.)

12027 AUTOMATIC CONTROL SYSTEM FOR THE ELECTROMAGNETIC FIELD OF A PROTON SYNCHROTRON. F. M. Kulakov. p.18-43 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

A new control system was developed that ensures a specified reproducibility of the rise and fall of the field from cycle to cycle, maintains the specified tolerance for the high-frequency pulsations in the field rise curve, and provides a field fall-off within a minimum time. The system was used with the existing SSSR 7 and 0.2 Bev proton synchrotrons, and is being designed for the 70 Bev accelerator now under construction. The automatic control system was made variable from one part of the cycle to the other. The desired transient quality in the field variation is insured on the rise part of the cycle by introducing a forcing signal into the system and by using control signals proportional to the error and its derivative, derivable from the excitation of the generator and the charging of the filter capacitance. Criteria for the evaluation of the system parameters are spelled out. The required transient quality on the decreasing part of the cycle is attained by proper selection of the parameters. Analytic solutions are derived for the calculation of the transient in the automatic control system. (auth)

12028 EXPERIMENTAL INVESTIGATION OF MAGNET STRUCTURES IN A SECTION CYCLOTRON, WITH A WIDE RANGE OF PARTICLE ENERGY VARIATIONS. A. G. Alekseev, Yu. G. Basargin, R. N. Litunovskii, and A. V. Stepanov. p.44-52 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Various isochronous cyclotron magnetic structures were examined, and measurements were taken of 342 and 685 mm electromagnets. The 342 mm magnet was studied in order to determine the most efficient magnetic structure for an isochronous cyclotron operating with a wide range of particle energies in an ordinary dee system or in a sector dee distributed in large gaps. The model with 685 mm pole diameter was used for a detailed analysis of preliminary selected magnetic structures. (R.V.J.)

12029 ALIGNING OF CYCLOTRONS WITH 120 cm POLE DIAMETER ELECTROMAGNETS. A. G. Alekseev, B. P. Angelov, Yu. G. Basargin, et al. p.53-70 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Installation and alignment of a U-120-1 cyclotron are described, and the basic parameters and the performance curve of the installation are analyzed. The U-120-1 cyclotron exhibited excellent operational stability and at continuous operation (8 to 10 hr per day) maintained a mean H_2^+ ion beam current of 500 to 1000 μ amp in the accelerating chamber. Maximum currents (in the pulse) were ~2000μ amp. For deuteron acceleration the beam intensity increased 2 to 2.5 times. On a remote target the deuteron current was about 80 μ amp. (R.V.J.)

12030 DESIGN OF ION-OPTICAL SYSTEMS FOR DIRECT-ACTION ACCELERATORS WITH ALLOWANCE FOR SPACE CHARGE. V. S. Kuznetsov. p.83-96 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

General relations between the parameters of the beam at the entrance and exit of an accelerator tube were found and a method for calculating the optimal values of the input parameters of the beam is described. The parameters involved are the beam radius, its divergence angle, the beam current, the electrostatic field intensity, and the charge and mass of the particles. The design of focusing systems that ensure the required beam parameters in a specified location and the shaping of the beam by means of electrostatic focusing ahead of the accelerator tube is also considered. It is shown that a parallel beam can be obtained at the output of the tube by using a lens system of suitable convergence, regardless of the conditions at the input. Since lenses made up of cylindrical electrodes are much weaker than lens-diaphragms (of the same diameter), it is advantageous to use accelerator tube parameters such that the main role in the shaping of the beam is played by the entrance lens of the focusing system, situated in front of the tube. The entrance lens in the tube itself, which is regarded as a diaphragm, is also part of the focusing system. (auth)

12031 PULSED HIGH-CURRENT IONIC SOURCE. M. A. Abroyan and V. L. Komarov. p.119-33 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Descriptions are given of a duoplasmatron type pulsed ion source developed for a synchrocyclotron injector. The ion source was developed using the plasma generation principle. The experiments indicated the feasibility of focusing ion beams with the current of nearly 170 mamp and minimum 10 mm diameter at 70 kev. (R.V.J.)

12032 HIGH-VOLTAGE TRI-ELECTRODE ELECTRON CANNON. K. P. Rybas and A. T. Ermolaev. p.134-43 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

The influence of cathode position along the Pierce cannon axis on the focusing of the beam and other cannon parameters was studied. The obtained data were used for developing a tri-electrode electron cannon, operating at 80 kv with the beam current of 5 amp, which is capable of varying the beam current intensity without changing the divergence angle or the beam energy. (R.V.J.)

12033 HIGH-FREQUENCY ION SOURCE FOR DIRECT ACTION ACCELERATORS. L. I. Ivanova and A. I. Solnyshkov. p.144-9 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Descriptions are given of a compact ion source for use with a 2-Mev electrostatic generator. The ion source is capable of producing 100- to 400-μamp ion beams with the gas consumption of 1 to 2 cm^3/hr. Larger currents can be obtained with larger openings in the deflecting ion system. (R.V.J.)

12034 RESONANT METHOD OF INVESTIGATING LOADED WAVEGUIDES. V. L. Smirnov and N. B. Uspenskii. p.166-72 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Loaded waveguides were investigated by a resonant method which determined the absolute value of the resonant natural frequency with accuracy $\pm 2.2 \times 10^{-5}$, the relative frequency with accuracy $\pm 7 \times 10^{-6}$, and the Q accurate to

±10%. The operation of the apparatus and its principal units are described. The influence of the temperature and of the degree of vacuum on the accuracy were analyzed. The accuracy can be increased by more careful calibration of the standard loaded cavity used for the measurements, and by using a high grade echo-resonator. The corrections for the influence of the temperature and of the vacuum conditions reduce the measurements to conditions at which the loaded waveguide may be used in linear electron accelerators. (auth)

12035 SINGULARITIES OF PULSE EXCITATIONS IN RESONANCE SUPPLY SYSTEMS FOR HIGH-ENERGY SYNCHROTRON ELECTROMAGNETS. R. S. Bobikov, B. V. Pleteney, F. M. Spevakova, and A. M. Stolov. p.176-92 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Studies of a pulse resonance servo-system for the high-energy synchrotron electromagnet showed the feasibility of using the push-pull pulse excitation system which creates magnetic field intensity distortions not exceeding the tolerances of particle motion conditions. The pulse servo-system is very flexible for operation with various resonance contour frequencies. (R.V.J.)

12036 VACUUM CHAMBERS FOR STRONG-FOCUSING SYNCHROTRONS. I. F. Mal'shev, A. V. Popkovich, P. A. Fefelov, and Yu. A. Sokolov. p.193-203 of "Elektrofizicheskaya Apparatura. Vypusk I." Moscow, Gosatomizdat, 1963. (In Russian)

Designs of vacuum chambers for strong-focusing accelerators, developed in recent years in NIIEFA, are described. A description is given of accelerator vacuum chambers considering the uniformity of the field, injection energy, injection geometry, intensity, the chamber aperture, the required vacuum, the materials, and other factors. A description is also given of the 7-Bev proton synchrotron and the 6-Bev proton synchrotron vacuum chamber and their individual parts. The 7-Bev proton synchrotron vacuum chamber consists of a ring about 80 mm in diameter having 112 curvilinear sections placed in the gaps of the magnet blocks, and 112 straight-line sections between the blocks. The main elements of the ring are the curved sections, the majority of which constitute thin corrugated tubes of elliptical cross section with flanges welded on the end. Each tube is approximately 2 meters long, has inside dimensions 84 × 114 mm (axes of the ellipse), and is made of 1Kh18N9T stainless steel 3 mm thick, the corrugations being 3 mm high at a spacing of 7 mm. The 6-Bev electron synchrotron ring is approximately 70 m in diameter, consisting of 48 curvilinear sections and 48 straight-line sections. Each curvilinear section (radius of curvature ~25 meters) is approximately 3.8 m long and has inside dimensions 44 × 120 mm. The tube is 1.5 mm thick and is not corrugated. The forms used to shape the vacuum chamber tubes are described, along with the vacuum systems. (auth)

12037 THE APPLICATION OF SUPERCONDUCTIVITY TO LINEAR ACCELERATORS. A. P. Banford (Rutherford High Energy Lab., Chilton, Didcot, Berks, Eng.). 12p. (CONF-554-12)

From Cryogenic Engineering Conference, Philadelphia, Aug. 1964.

Linear accelerators, whether for protons or electrons, require large quantities of radio-frequency power in the 200 or 3000 Mc region, and for technical and economic reasons are operated in a pulsed manner. If the surfaces of the accelerating structure were made superconducting, substantial reductions in the r-f power requirements would result, leading to continuous operation. An outline of the mechanism of r-f losses in metals is given followed by a discussion of some cryogenic and microwave problems. Recent experimental work at proton linac frequencies is reported. (auth)

12038 MAGNET FOR A FIXED-FREQUENCY CYCLOTRON WITH AN AZIMUTHALLY VARYING MAGNETIC FIELD. Karl Steimel (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,180,076. Oct. 22, 1964. Filed Jan. 7, 1961.

The distance between the pole plates is larger in the central portion of the plates than in the surrounding annular portion of the magnet. The magnetization of the central portion is reduced by a magnetic series resistance in such a way that the average magnetic field intensity in the central portion is not higher than the field intensity in the surrounding annular portion. (Gmelin Inst.)

12039 METHOD OF TUNING TO RESONANCE A CYCLOTRON, E.G. A THREE SECTOR TYPE CYCLOTRON. Hans-Helmut Feldmann (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,180,077. Oct. 22, 1964. Filed July 14, 1961.

A method for tuning a cyclotron to resonance is described. It consists of comparing the phase of the ion pulses rotating on the outer paths with the phase of the accelerating radiofrequency (phase control), and of comparing the radiofrequency with the guide frequency (frequency control). In order to establish conditions of resonance even when the variation of the average air gap induction exceeds 10^{-4} the guide frequency is controlled with dependence of the phase of the ion pulses relative to the phase of the radiofrequency. (Gmelin Inst.)

Astrophysics and Cosmology

Refer also to abstracts 11398, 12346, and 12604.

12040 (UCRL-Trans-1114(L)) SUPERDENSE STATE OF MATTER IN THE UNIVERSE. G. S. Saakyan. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk, 15: No. 1, 123-34(1962). 19p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

Assuming the distribution of matter in the universe to be homogeneous and isotropic, its physical properties are shown to be characterizable by four parameters, namely electric, baryon, and lepton charge, and total gravitational energy. These parameters are invariant, so that if their values are known, the state of the matter in the universe is determined only by the volume of the universe. Near-equilibrium conditions are assumed. (T.F.H.)

12041 ESCAPE OF MATTER FROM CHROMOSPHERE AND ACTIVE REGIONS. B. Valníček (Astronomical Inst., Czechoslovak Academy of Sciences, Ondřejov). Bull. Astron. Inst. Czech., 15: 207-10(1964).

Comparison of curves representing the velocity changes of matter emanating from explosive flares and blow-off prominences indicates a difference in the nature of both processes. A comparison of the situation of fast processes in relation to active regions and to the degree of their activity corroborates the influence of the configuration of magnetic fields on the formation of favorable conditions for a high-velocity escape of matter into space from these regions. (auth)

12042 PRELIMINARY CURVES OF GROWTH FOR IRON EMISSION LINES IN THE FLARE OF JULY 20, 1958. V. Letfus (Astronomical Inst., Czechoslovak Academy of Sciences, Ondřejov). Bull. Astron. Inst. Czech., 15: 211-22(1964).

A method is described of solving the emission curve of growth for a chromospheric flare on the disk. The emission lines are on the background of a Fraunhofer spectrum of the photosphere, and the determination of the excitation temperature by a method developed by Letfus (1961) makes it necessary to carry out a reduction of the observed equivalent widths of lines into actual ones. The reductions are part of an iteration process for determining excitation temperatures. The method was applied to a portion of the emission spectrum of the flare of July 20, 1958, in the region of the H_γ line. Several iron lines are blended by titanium lines. The reductions, which permit the determination of the actual intensity of both components of the blended lines, can be performed by using a modified expres-

sion for the emission curve of growth. Excitation temperatures of 4690°K for Fe I lines and 5350°K for Fe II lines were obtained. For $n_e = 6.10^{13}$ an ionization temperature of 6850°K was found. For $T_e = 9000$°K the ionization deviation from LTE is $\beta = 85$. From the curve of growth follows a microturbulent velocity of $\xi_t = 5.8$ km/sec. Švestka (1961) carried out an analysis of the same flare with respect to the line profiles of the Balmer series of hydrogen and derived large macroturbulent non-Maxwellian velocities (~200 km/sec). The differences between the results of the two investigations are discussed. The broadening of the hydrogen lines can be interpreted as Stark effect. In this case the ratio of iron and hydrogen is within a reasonable range, but the high electron concentration ($n_e \sim 6.10^{13}$) leads to a filamentary structure of the flare ($h_{eff} \leqq 10$ km). (auth)

12043 FLARES, RADIO BURSTS, AND MAGNETIC STORMS. L. Fritzová-Švestková and F. Hřebík (Astronomical Inst., Czechoslovak Academy of Sciences, Ondřejov). Bull. Astron. Inst. Czech., 15: 222-7(1964).

A list is presented of all significant flares, radio bursts of type IV, and magnetic storms during the period from July 1, 1957, to the end of 1961, arranged according to their mutual relations. Only those cases when these relations (or the nonexistence of such relations) could be ascertained without any doubt are taken into account. It is concluded that there are many great magnetic storms which can not be associated with the appearance of great flares on the visible hemisphere of the solar disc, and some great flares which do not cause any significant geomagnetic storm. It is also confirmed that practically all flares associated with a type-IV radio burst are sources of solar corpuscular emission which causes geomagnetic storms. (auth)

12044 THE MAGNETIC FIELD IN PLANETARY NEBULAE. I. GENERAL SUGGESTIONS. E. Chvojková (Astronomical Inst., Czechoslovak Academy of Sciences, Prague). Bull. Astron. Inst. Czech., 15: 241-9(1964).

Intense plasma jets bursting from the magnetic poles of a central star, their spreading out across magnetic lines towards the magnetic equator, and their permanent streaming along magnetic loops seem to be different types or stages of development of planetary nebulae. Their shapes depend upon the magnetic field of the central star. In strong magnetic fields, only narrow, dense, rectilinear filaments stream from the magnetic poles of the central star. After reaching higher altitudes, where the magnetic field is decreased and the effect of rotation prevails, the stream becomes an unwinding spiral. In a weak magnetic field all three types of planetary nebulae are present, and even a smaller elliptical cloud, enveloping the central star, can appear. The plasma streams from a large polar region into a large solid angle, producing not only the polar cap but also the streaming along magnetic loops. This last phenomenon varies according to the component of the plasma stream velocity along the magnetic field. If the movement along magnetic loops is slowed down, levels of the magnetic mirrors can rise towards the top of the loop where the plasma accumulates. (auth)

12045 MEASUREMENT OF THE RADIOACTIVITY INDUCED BY COSMIC RADIATION IN THE BOGOU METEORITE. Daniel Nordemann and Jacques Tobailem (Centre d'Etudes Nucléaires, Saclay, France and C.N.R.S., Gif-sur-Yvette, France). Compt. Rend., 259: 3581-3 (Nov. 16, 1964). (In French)

The activities of γ emitters contained in a 0.185-kg sample of the Bogou iron meteorite (which fell Aug. 14, 1962) was measured by quantitative γ spectrometry with slight self-movement. (tr-auth)

12046 MEASUREMENT OF THE MAGNITUDE OF THE MAGNETIC FIELD ON THE SUN. B. A. Ioshpa and V. N. Obridko (Inst. of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 12-17(1964).

A method is described for simultaneously measuring the magnitude and direction of the magnetic field on the sun. It is shown that it is sufficient to measure the Stokes parameters of incoming radiation J, Q, and V and the azimuth of the magnetic field in the image plane Φ. For this purpose the following changes are made on the longitudinal magnetograph vector: a $\lambda/4$ plate is placed in front of the electro-optic crystal at an angle of 30° to the axes of the crystal, a measuring device is set to a fundamental modulation frequency, adding the signals from both wings of the line, and two measuring devices are set at a double frequency, one adding, and the other subtracting the signals from both wings of the line. The constant component of intensity of the wing of the line is measured. The lower limit of measurement of the transverse field is 150 oersteds. The results of observations in a sunspot region are reported. (auth)

12047 MAGNETIC FIELD OF ARCH SYSTEMS IN THE SOLAR CORONA. V. I. Ivanchuk (Kiev State Univ.). Geomagnetism Aeronomy, 4: 18-23(1964).

The importance of studying the magnetic fields of the sun by investigating structural formations in the corona is discussed. Reasons are given for the belief that arches and arch systems are not shells or cupolas, but real flat arches, i.e., materialized bundles of magnetic lines of force. Arch systems reflect the configuration of the magnetic field in a given region. It was found that some arches are empty spaces in the luminous coronal plasma. This explains the relation between prominences and arches, assuming that the arches are traces of precipitated prominences. The decrease in gas kinetic pressure inside an arch is compensated by an increase in magnetic pressure. This assumption is used to find a solution to the magnetohydrostatic equation as applied to a flaring up magnetic arch. An equation is obtained for a magnetic line of force, which complies with the form of observed coronal arches and the pattern of the compression of the arches with height. The intensity of the magnetic field in the arches is estimated at ~0.5 gauss for their summits ($h \approx 0.5R_\odot$). (auth)

12048 THE POSSIBLE MAGNETIC FIELD STRUCTURE OF GEOEFFECTIVE CORPUSCULAR STREAMS FROM MARINER II MEASUREMENTS. E. I. Mogilevskii (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 166-73(1964). Translated from Geomagnetizm i Aeronomiya, 4: 213-23(1964).

A three-dimensional model of the magnetic field of a solar geoeffective corpuscular stream is presented from magnetic field measurements on Mariner II during a geomagnetic disturbance. Qualitative examination of the model and some quantitative estimates show that the observed picture of the magnetic field is in satisfactory agreement with a corpuscular stream model having a force-free magnetic field. (auth)

12049 THE SOLAR WIND AND SOLAR CORPUSCULAR STREAMS. S. K. Vsekhsvyatskii (Kiev State Univ.). Geomagnetism Aeronomy, 4: 255-8(1964). Translated from Geomagnetizm i Aeronomiya, 4: 328-32(1964).

Correspondence is noted between the structure of the outer corona and geomagnetic field variations for the periods of a number of eclipses and between the geomagnetic curve and the situation in the solar chromosphere. These data indicate that the system of solar corpuscular streams is one of straight lines and that such streams possess considerable stability. A study was made of correlation between 27-day series of daily K_p indices. It is established that high values of the correlation coefficients exist mainly for epochs of low solar activity and for periods of maximum values of the earth's heliographic latitude. It follows from these results that the system of corpuscular streams rotating with the sun is stable. Geomagnetic field variations reflect the structure of the outer corona in the ecliptic plane on the earth's orbit. (auth)

12050 THE PROPERTIES OF THE SOLAR WIND FROM PERMANENT GEOMAGNETIC DISTURBANCES ON DAYS WITH RATHER LOW Kp. M. S. Bobrov, N. F. Koroleva, and R. M. Novikova (Astronomy Council, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 259-64

(1964). Translated from Geomagnetizm i Aeronomiya, 4: 333-41(1964).

Consideration is given to the permanent geomagnetic disturbances of the polar caps on days of rather low planetary magnetic activity (P_0 disturbances). It is demonstrated that P_0 disturbances are generated by the solar wind, and it is established by analysis that, during the period under consideration, the solar wind was an approximately radial corpuscular stream, permanent in time, whose intensity was only slightly dependent (or not dependent at all) on the phase of the solar cycle. The sources of the solar wind were approximately uniformly distributed through heliocentric longitudes, and did not reveal any connection with active formations on the sun. (auth)

12051 COSMIC-RAY INTENSITY INCREASE IN THE HARD COMPONENT DURING "SMALL" CHROMOSPHERIC FLARES ON THE SUN. L. I. Dorman, V. I. Ivanov, and E. V. Kolomeyets (Kazakh State Univ., USSR). Geomagnetism Aeronomy, 4: 311-13(1964). Translated from Geomagnetizm i Aeronomiya, 4: 399-401(1964).

An analysis of 170 flares of scale 2 was undertaken to determine the cosmic-ray intensity increase in the hard component during small chromospheric flares. The investigation was conducted by the superposed epochs method, taking the time of commencement of the chromospheric flare as the zero hour. Daily variation was excluded by subtracting the daily variation of the previous day. The stations whose observations were employed, the cut-off rigidity, the type of instrument, and the amplitude of the effect are tabulated. It is shown that the effect of the increase does not exceed 0.1%. (C.E.S.)

12052 CORRELATION BETWEEN THE SECULAR VARIATION OF COSMIC-RAY INTENSITY IN THE STRATOSPHERE AND SOLAR ACTIVITY. B. D. Fomenko (Volgograd State Pedagogical Inst., USSR). Geomagnetism Aeronomy, 4: 313-14(1964). Translated from Geomagnetizm i Aeronomiya, 4: 402(1964).

Graphs depicting variation of the mean monthly values of cosmic-ray intensity and the total number of chromospheric flares whose corpuscular streams entrapped the earth are illustrated. Comparison of the graphs provides a demonstration of the existence of a connection between reductions of cosmic-ray intensity in the stratosphere and the frequency with which the earth enters corpuscular streams in years of maximum solar activity. (C.E.S.)

12053 COSMOLOGICAL RED-SHIFT. L. M. Stephenson (University Coll., London). Nature, 204: 1180(Dec. 19, 1964).

Information concerning deductions is presented to emphasize the fact that very different initial assumptions as to the continuous creation of matter or the shielding or absorption of gravitational flux lead to similar results. In neither of these approaches is the red-shift related quantitatively with the initial assumption, indicating that a fundamental relation exists. (J.R.D.)

12054 ESTIMATION OF HALF-LIVES FROM METEORITIC DATA. Michael E. Lipschutz (Universität, Bern). Nature, 204: 1289-90(Dec. 26, 1964).

Studies were made on the use of data on cosmic ray nuclear interaction effects in meteorites for the determination of approximate half lives. Estimation of the half life of ^{44}Ti is illustrated. If the ratios of the concentrations of a number of cosmogenic nuclides can be obtained between two meteorites of known terrestrial ages, t_1 and t_2 a theoretical ^{44}Ti ratio, R_0, can be calculated, which is already corrected for shielding effects. It was found that the ^{44}Ti half life almost certainly is less than 160 years, and its most probable value is about 36 years. Comparison with the actual ^{44}Ti half life, 48.2 ± 0.9 years, indicates that the meteoritic technique seems potentially more accurate than cross section arguments for such estimations. (P.C.H.)

12055 NEUTRINO EMISSION FROM STAR-LIKE SOURCES. D. Boccaletti, V. de Sabbata, and C. Gualdi (Universita, Bologna). Nature, 205: 60(Jan. 2, 1965).

The evaluation of neutrino emission from star-like sources is presented. It is assumed that the star-like sources emit 10^{48} ergs/sec as neutrino power. Because the energies of the neutrons are of the order of a Mev, an emission of $\sim 10^{54}$ ν/sec/star-like source is obtained. Next supposing that the star-like sources are young galaxies that are confined inside a shell out of the until now observed universe, 10^8 star-like (that is, one-tenth of the estimated number of galaxies) may be found. Thus $10^{54}/10^8 = 10^{62}$ ν/sec. Since the process goes on for about 10^6 years, the output of neutrino antineutrino pairs is 10^{76}. On the whole universe, this makes a density of $10^{76}/10^{84} = 10^{-8}$ ν/cm^3. (P.C.H.)

12056 ACCELERATION OF CHARGED PARTICLES BY A RADIATION BEAM. L. E. Gurevich and A. A. Rumyanstev (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 1829-31(Nov. 1964). (In Russian)

Acceleration of charged particles by a beam of radiation as a result of Compton scattering of the beam photons on electrons is considered. It is shown that for the radiation fluxes encountered in nature (such as during supernova flares) nuclei may acquire energies of the order of their rest energy. (auth)

12057 MACH'S PRINCIPLE AND EXPERIMENTS ON MASS ANISOTROPY. V. W. Hughes. p.106-20 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

Possible observable effects of an anisotropy of inertial mass in the universe are discussed, together with experiments performed in an attempt to observe such effects. (D.C.W.)

12058 THE SIGNIFICANCE FOR THE SOLAR SYSTEM OF TIME-VARYING GRAVITATION. R. H. Dicke. p.142-74 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

A modification of Einsteins equations to include a scalar long-range field is outlined. The modified equations appear to be compatible with Mach's principle and also imply a position- and time-varying gravitational constant. Some astrophysical and geophysical effects of a time-varying constant are discussed. (D.C.W.)

12059 THE SUPERDENSE STAR AND THE CRITICAL NUCLEON NUMBER. John A. Wheeler. p.195-230 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The stability of a system of nucleons drawn together by gravitational forces is analyzed. The breakdown of valence and nuclear forces, the equation of state, pressure effects, equilibrium configurations, and the critical mass at which collapse begins are considered. (D.C.W.)

12060 POSSIBLE EFFECTS ON THE SOLAR SYSTEM OF φ WAVES IF THEY EXIST. R. H. Dicke. p.241-57 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The properties of waves in a long-range scalar field are reviewed. Astronomical sources of φ waves are discussed, together with the hypothetical galactic effects of φ waves and effects on the solar system. Earthquakes, irregularities in the moon's motion, and variations in the earth's rotation are considered in terms of φ-wave effects. (D.C.W.)

Atomic Physics

12061 (PA-TR-3153) RATES OF IONIZATION AND RECOMBINNATION PROCESSES IN HEATED AIR. James H. Renken (Picatinny Arsenal. Feltman Research and Engineering Labs., Dover, N. J.). July 1964. 39p. (AD-444343)

The procedures used to calculate rate constants for certain ionization and recombination reactions are described. Results of calculations based upon these procedures, and analytical expressions that approximate the values found

with the computer are presented. The only recombination reactions treated are those that yield a hydrogenic ion. Extension of the formalism to cases where multi-electron ions are formed is restricted primarily by the lack of convenient radiative transition rate information for multi-electron systems. (auth)

12062 FACTORIZATION OF THE RADIAL EQUATION FOR THE HYDROGEN ATOM. Zevi W. Salsburg (William Marsh Rice Univ., Houston, Tex.). Am. J. Phys., 33: 36-9 (Jan. 1965).

The radial equation for the hydrogen atom problem is factored to yield raising and lowering operators for the orbital angular momentum quantum number l. This procedure, which is a direct analog for the usual treatment of the angular momentum operators, is considered to offer many pedagogical advantages for an introductory course in quantum mechanics over the usual series method of solution. The raising process is terminated by establishing the existence of an upper bound for l. The use of the hypervirial relations is advocated for displaying such an a priori upper bound. (auth)

12063 ON THE EVALUATION OF THE CONTINUOUS X-RAY SMALL-ANGLE SCATTERING OF TRIAXIAL ELLIPSOIDS. Peter Klimanek (Institut fur Metallkunde und Materialprufung, Bergakademie, Freiberg, Ger.). Ann. Physik (7), 14: 71-7(1964). (In German)

A method was discussed for the evaluation of continuous x-ray small-angle scattering in triaxial ellipsoids, based on the general method for rotational ellipsoids by introducing the factor of coherence length into the applicable formulas. The techniques involved in the method and potential sources were discussed. (OTS)

12064 BETA SPECTRUM SHAPES OF NON-UNIQUE FIRST FORBIDDEN TRANSITIONS AND NUCLEAR STRUCTURE. Kazuo Hisatake (Tokyo Inst. of Tech.). Genshikaku Kenkyu, 9: No. 1, 12-35(Apr. 1964). (In Japanese)

The possibility of nuclear structure information from beta spectrum shapes of non-unique first forbidden transitions is discussed. Almost all beta active isotopes of non-unique first forbidden transitions whose half lives are between 30 minutes and 5 years are listed with their ft values and shape factors when available. The beta-gamma coincidence method is emphasized for resolving complex spectra. Experimental errors in obtaining shape factors are discussed and estimated to be 1.5%. (auth)

12065 SEMICLASSICAL CALCULATION OF INELASTIC CROSS SECTIONS FOR ELECTRON-CESIUM ATOMIC COLLISIONS. John W. Sheldon and John V. Dugan, Jr. (Lewis Research Center, Cleveland). J. Appl. Phys., 36: 650-1(Feb. 1965).

The theory of Gryzinski (Phys. Rev. 115,374(1959)) is used to obtain semiclassical inelastic cross sections for electron–cesium atomic collisions. The universal ionization cross section from classical theory, the absolute value of the ionization cross section peak, electron-induced cesium excitation cross sections, and the electron-induced ionization cross section of excited (6P) cesium atoms are presented. (C.E.S.)

12066 EFFECT OF SCATTERING ON CHARGE TRANSFER EFFICIENCY MEASUREMENTS: COMMENT ON A PAPER BY MAHADEVAN ET AL. J. R. Peterson (Stanford Research Inst., Menlo Park, Calif.). J. Appl. Phys. 36: 652-3(Feb. 1965).

A discrepancy between two operational definitions of the charge transfer efficiency of a gas for 1.0- to 2.5-kev argon and neon ions penetrating their parent gases as observed by Mahadevan et al. (J. Appl. Phys. 34, 2810(1963)) is discussed. Known properties of resonant charge transfer collisions are use to estimate the total scattering cross sections required to account for the experimental results of Mahadevan et al. (C.E.S.)

12067 CONTINUOUS REPRESENTATIONS IN THE STATISTICAL THEORY OF ELECTRONIC ENERGIES. THE SELF-CONSISTENT FIELD. George S. Handler and Sidney Golden (Tufts Univ., Medford, Mass.). J. Chem. Phys., 42: 1290-3(Feb. 15, 1965).

A self-consistent-field approximation was applied to the continuous-representation version of statistical theory. Calculations were carried out for $He(^3S$ and $^1S)$, $Be^{2+}(^1S)$, $Be(^1S)$, and $Ne(^1S)$. Binding energies were about 6% greater than experimental values. No shell structure in electron density was obtained, however, which reflects an inadequacy of the theory in approximating such properties. Nevertheless, the densities obtained gave relatively good estimates of the mean values of r^n, $-2 \leq n \leq +2$. (auth)

12068 ANALYTICAL EXPRESSIONS FOR THE TOTAL ELASTIC CROSS SECTION OF ELECTRON SCATTERING BY THOMAS-FERMI-DIRAC AND HARTREE-FOCK ATOM. T. Tietz (Indiana Univ., Bloomington). J. Chem. Phys., 42: 1462-3(Feb. 15, 1965).

Analytical expressions are given for the total cross section of electron scattering by Thomas-Fermi-Dirac (TFD) and Hartree-Fock (HF) atom in the first Born approximation. (M.C.G.)

12069 LOW-FREQUENCY MOTIONS OF H_2O MOLECULES IN BERYL FROM NEUTRON INELASTIC SCATTERING DATA. H. Boutin, H. Prask, and G. J. Stafford (Picatinny Arsenal, Dover, N. J.). J. Chem. Phys., 42: 1469-70 (Feb. 15, 1965).

The time-of-flight spectrum of neutrons inelastically scattered at room temperature by a sample of beryl containing about 1% adsorbed water showed no peak around 0.060 to 0.080 ev, in a region where the torsional motions of the H_2O molecules in a crystal are usually observed. With studies at both 293 and 100°K, the data indicated that the H_2O molecules in beryl are not freely rotating, as previously suggested, but undergo hindered oscillations around the axis of symmetry. It was also concluded that the potential in which the H_2O molecule is moving is anharmonic. (M.C.G.)

12070 SPONTANEOUS TRANSITION PROBABILITIES IN HIGHLY EXCITED HYDROGEN ATOMS. Robert M. May (Univ. of Sydney). Nucl. Fusion, 4: 244-5(Sept. 1964).

A derivation of the asymptotic values of the total transition probabilities for states with $n \gg 1$ and $l = 0, 1, 2$, and 3 is presented. A new sum rule that enables one to put an upper and lower bound on the transition probabilities is derived. These bounds are useful both when $l \gg 1$ ($l \approx n$) and when one is concerned with the average lifetime of the n^{th} quantum state (averaged over l). (C.E.S.)

12071 MEASUREMENT OF ABSOLUTE DIFFERENTIAL CROSS SECTIONS OF Co^{60} PHOTONS FOR THE COMPTON EFFECT. A. M. Ghose (Bose Inst., Calcutta). Nucl. Phys., 65: 145-55(May 1965).

Absolute values of the differential collision cross sections of ^{60}Co photons (1.17 and 1.33 Mev) were measured in the angular range of 13 to 140°. A uniform spectral sensitivity photon counter was used in the measurement of relative values of the cross sections. Corrections were made for the effects of self absorption in the source and small deviations of the detector efficiency from uniformity. Detailed analysis was made of the multiple scattering and absorption phenomena occurring in cylindrical copper scatterers, and an empirical procedure was developed to eliminate errors caused by them. Accurate relative values obtained in this manner were converted into absolute differential cross sections through an integral measurement in which the effects of photons scattered by angles smaller than 13° are automatically eliminated. The root mean square deviation of the experimental values from the corresponding Klein-Nishina cross section is 1.5%, which is within the rms spread, 3.5%, of the probable error of the experimental points. The experimental points completely rule out the distribution formulas of Breit, Gordon, and Dirac. (auth)

12072 CALORIMETRIC METHOD OF DETERMINING THE TOTAL ENERGY OF ELECTRON BEAM. Masao Yoshimura and Kiyoshi Hamanaka (Tokyo Metropolitan

Isotope Center). Oyo Butsuri, 33: 306-12(May 1964). (In Japanese)

A calorimetric method of determining the total energy of high-energy electron beams is discussed. Measurements made with 1 ~ 3 Mev and 10 ~ 100 μamp electron beams proved that the use of a calorimeter gives satisfactory results. The relations of calorimetrically determined total backscattered energy from targets of Al, Cu, Ag, and Au to the atomic number and incident beam energy are described. Corrections of 32% to the observed value when Au with a 1-Mev beam was used, and 6.8, 3.7 and 2.3% when Al with 1-, 2- and 3-Mev beams, respectively were used were found necessary. (auth)

12073 ON THE TEMPERATURE DEPENDENCE OF THE TRANSPARENCY OF POLYCRYSTALLINE LAYERS FOR ELECTRONS. O. Bostanjoglo and H. Niedrig (Technische Universität, Berlin). Phys. Letters, 13: 23-4 (Nov. 1, 1964). (In German)

Measurements of the transparency of polycrystalline layers (Be, Al, Cu, Ag, Au, Pb, and Bi) to 30-kev electrons gave for the primary beam an exponential dependence on temperature and layer thickness. In order to consider the temperature effect, a Debye spectrum of elastic waves was assumed in the crystal. The expressions on the temperature effect were derived and evaluated. The theoretical results obtained were compared with the experimental results. (J.S.R.)

12074 THE BCS-BOGOLYUBOV EQUATION FOR THE MOTT INSULATOR-METAL TRANSITION. G. Kemeny (Kennecott Copper Corp., Lexington, Mass.). Phys. Letters, 14: 87-8(Jan. 15, 1965).

It is shown that the BCS-Bogolyubov equation for electron pairs in the theory of superconductivity is also valid for electron-hole pairs in the theory of the Mott-type insulator-metal transition. (L.B.S.)

12075 EXCITATION OF H ATOMS BY PROTON IMPACT. R. M. May (Univ. of Sydney). Phys. Letters, 14: 98-9(Jan. 15, 1965).

The total cross section for excitation of ground state hydrogen atoms by proton impact according to the reaction, $H^+ + H(1s) \rightarrow H^+ + H(n,l,m_l)$, was calculated. The energy dependent form factor is tabulated as a function of incident proton energy. It is concluded that very energetic protons (>> 25 kev) give rise predominantly to excited p states. (L.B.S.)

12076 INELASTIC SCATTERING OF COLD NEUTRONS BY LOCALISED MODES IN VANADIUM HYDRIDE SYSTEMS. R. Rubin, J. Peretti, G. Verdan, and W. Kley (EURATOM, Ispra, Italy). Phys. Letters, 14: 100-2(Jan. 15, 1965).

The spectra of neutrons inelastically scattered by pure vanadium at room temperature and by vanadium hydride (4 at. %) at 150°C were measured using the time-of-flight method. A distinct peak was observed around 100 mev for the vanadium hydride system, which gives clear evidence of a localized mode of hydrogen in the vanadium lattice. (L.B.S.)

12077 TOTAL CROSS SECTION FOR PROTON EXCITATION OF H ATOMS. S. T. Butler and L. Parcell (Univ. of Sydney). Phys. Letters, 14: 110-11(Jan. 15, 1965).

The cross section for excitation to all discrete levels of a hydrogen atom by collision with a proton is calculated using closure relations and the Born approximation. Elastic and ionization contributions are subtracted. The results are tabulated and are compared with the cross section for excitation to states of principal quantum numbers 2 and 3. (L.B.S.)

12078 ANISOTROPIC EMISSION OF α^- PARTICLES FROM A MONOCRYSTALLINE SOURCE. B. Domeij and K. Bjoerkqvist (Research Inst. of Physics, Stockholm). Phys. Letters, 14: 127-8(Jan. 15, 1965).

^{222}Rn ions of 60 kev energy were injected into a W single crystal cut perpendicular to the (111) direction, and measurements were made of the intensity of the α particles emitted from the source as a function of emission angle for three different α groups. A drop in intensity to 0.28 was observed for particles emitted parallel to the direction of a row of atoms, and reasons for deviation of the minimum intensity from zero are proposed. (L.B.S.)

12079 CHARGE TRANSFER BETWEEN Li IONS AND Li ATOMS IN THE 14-1000-ev ENERGY REGION. D. C. Lorents (Stanford Research Inst., Menlo Park, Calif.), G. Black, and O. Heinz. Phys. Rev., 137: A1049-53 (Feb. 15, 1965).

By means of a crossed-beam technique, the absolute cross section for charge transfer between lithium ions and lithium atoms was measured for incident ion energies ranging from 14 to 1000 ev. The lithium ions are produced thermally in a β-eucryptite source and are accelerated and focused into a ribbon beam in a Pierce gun. The total energy spread of the beam is less than 3% at all energies; mass analysis shows that above 1000°C emitter temperature the impurity ions in the beam are below 0.2%. This ion beam traverses a high-density, collimated lithium vapor beam issuing fron an oven. A typical density of neutral lithium atoms in the interaction region is 10^{13} atoms/cm^3. The slow ions produced in the charge-transfer interaction are collected on a negatively biased cage surrounding the interaction volume of the two beams. The slow-ion charge-transfer current completely accounts for the ion-beam attenuation, thus indicating that all scattered beam ions are collected. The vapor-beam density was determined by condensing the vapor on a cold target, dissolving the metallic lithium thus collected, and titrating the resulting solution. The cross section for transfer varies from 240×10^{-16} cm^2 at 14 ev incident ion energy to 80×10^{-18} cm^2 at 1000 ev, and has the expected energy dependence for resonant charge transfer $Q^{1/2} = 19.3 \times 10^{-8} - 3.5 \times 10^{-8} \log E$, where the incident ion energy E is in ev and Q is in cm^2. (auth)

12080 PHOTOIONIZATION CROSS SECTION OF HELIUM IN THE 100- TO 250-Å REGION. J. F. Lowry, D. H. Tomboulian, and D. L. Ederer (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 137: A1054-7(Feb. 15, 1965).

The absolute K-photoionization cross section of helium was measured in the region extending from 100 to 250 Å to a precision of 5% or better. Above 250 Å, where the present results overlap with earlier work, there is satisfactory agreement, and the data were combined so as to extend the range of measurements by about 18 Ry above the ionization threshold. It was possible to join these results with a previous observation made at a higher energy (20.3 Ry) so that helium is the only gas other than Ne for which the cross section is known over a large energy range with comparable precision. This information, combined with the outcome of theoretical calculations and with estimates of discrete oscillator strengths, has led to the evaluation of four sum rules. The calculations attest to the reliability of the observations. (auth)

12081 ABSOLUTE CROSS SECTIONS OF LITHIUM AND OTHER ALKALI METAL ATOMS FOR IONIZATION BY ELECTRONS. Robert H. McFarland and John D. Kinney (Univ. of California, Livermore). Phys. Rev., 137: A1058-61(Feb. 15, 1965). (UCRL-7915)

The absolute cross section for ionization by electron impact was measured for lithium, sodium, potassium, rubidium, and cesium by a modulated-crossed-beam technique. The measurement for lithium is described in detail, inasmuch as it has never been previously measured. The cross sections for the other alkali metals are included and compared with prior measurements for reference. (auth)

12082 THEORY OF SPIN EXCHANGE BETWEEN OPTICALLY PUMPED RUBIDIUM AND FOREIGN GAS NUCLEI. R. M. Herman (TRW Space Tech. Labs., Redondo Beach Calif.). Phys. Rev., 137: A1062-5(Feb. 15, 1965).

Cross sections for spin exchange between alkali valence electrons and foreign nuclei in collisions of atomic Rb with atomic He, Ne, Kr, and molecular hydrogen are calculated.

It is concluded that while classical dipolar hyperfine interactions are negligible, scalar interaction strengths are greatly magnified as a result of electron exchange. Specifically, it is shown that cross sections associated with the latter are as much as 10^5 times those calculated if exchange effects are neglected. For ^{3}He, ^{21}Ne, ^{83}Kr, H_2, and D_2, the estimated cross sections for mutual spin flip are 1.1×10^{-24}, 1.0×10^{-23}, 1.0×10^{-22}, 3.6×10^{-25}, and 5.5×10^{-26} cm^2. For ^{3}He and ^{21}Ne, these are comparable in magnitude to the corresponding experimental cross sections for the depolarization of optically oriented Rb. For the other gases considered, they are relatively much smaller, however. Cross sections for Rb electronic spin disorientation through spin-orbit interactions in collisions with molecular hydrogen are also calculated. They are considerably larger than those observed for the disorientation of optically pumped Rb vapor. (auth)

12083 FINITE-MASS HELIUM ATOMS. II. 2^3 P STATE. Milos Machacek, Frank C. Sanders, and Charles W. Scherr (Univ. of Texas, Austin). Phys. Rev., 137: A1066-7(Feb. 15, 1965).

The 2^3P states of the helium isoelectronic series are investigated via 50-term variational wave functions containing two nonlinear parameters. The hamiltonian, spin-free and nonrelativistic, is written directly in center-of-mass coordinates so that no adiabatic approximation is required. The expectation values of the hamiltonian and of moments of the interparticle separations are reported. Isotope shifts are found, and are in excellent agreement with experiment. In order to compare the results with previous theoretical results the systems were similarly studied in the infinite-nuclear-mass limit (adiabatic approximation). The energies so obtained are the deepest so far obtained by a direct calculation with a variational wave function. The expectation values of the operators were subjected to a differencing process to obtain estimates of the perturbation expansion coefficients for them, and the results are in good agreement with the directly calculated results of Knight and Scherr. (auth)

12084 EXTRAPOLATION OF CROSS-SECTION DATA TO ZERO ENERGY FOR LONG-RANGE EFFECTIVE POTENTIALS. R. Oppenheim Berger (New York Univ., New York), Thomas F. O'Malley, and Larry Spruch. Phys. Rev., 137: A1068-75(Feb. 15, 1965).

The effective one-body potential representing a particle–compound-system interaction usually has a very complicated short-range behavior, but a relatively simple, and more or less known, long-range tail U which can be nonlocal and energy-dependent. With U present, the usual effective-range-theory (ERT) expansion for a single-channel scattering phase shift η is inapplicable. Recent extensions of ERT include the effects of long-range potentials, but since η then becomes very energy-dependent, one would need many terms to obtain the desired accuracy, so the results are of restricted use. It is shown that one can first solve, numerically, a one-body problem which includes only U, and then use a modified ERT expansion for the difference δ between η and the phase shift due to U alone. Since the rapid energy dependence due to U is thus extracted out (exactly), terms in the expansion which depend upon the short-range potential in the presence of U are more slowly varying in energy; they involve a number of adjustable parameters to be determined experimentally, but only a few are usually needed. The procedure thus makes possible the extrapolation of low-energy scattering data down to zero energy, even when effective long-range potentials are present. (auth)

12085 A NEW METHOD FOR THE CALCULATION OF ONE-ELECTRON STATES IN CRYSTALS. H. Bross (Technische Hochschule, Stuttgart and Max-Planck-Institut für Metallforschung, Stuttgart). Physik Kondensierten Materie, 3: 119-38(Dec. 11, 1964). (In German)

A new method is presented for the calculation of wave functions and energy bands of electrons moving in a periodic potential in the one-electron approximation, which is based on different representations of the wave functions. The wave functions are expanded in spherical harmonics and radial solutions of the wave equation within a sphere inscribed in the atomic polyhedron. By suitable choice of the radial functions, it is possible to obtain wave functions which are well orthogonal to the functions of the core electrons. Outside the sphere the wave functions are expanded in plane waves having the correct translational symmetry. In contrast to other methods using similar expansions, the wave functions and their first derivatives in this method are continuous in all space. These trial functions are introduced into a variational principle equivalent to the Schroedinger equation, in which the conditions of continuity of the wave-functions and their first derivatives are taken into account by the method of undetermined multipliers. By an additional variation of the radial functions inside the sphere, one may obtain functions which approximate the real functions and leave only an uniform error in all space. (auth)

12086 RELATIVE SIGNS OF HYPERFINE COUPLING CONSTANTS BY A DOUBLE ENDOR EXPERIMENT. R. J. Cook and D. H. Whiffen (National Physical Lab., Teddington, Middx, Eng.). Proc. Phys. Soc. (London), 84: 845-8(Dec. 1964).

It is shown that the relative signs of the hyperfine coupling constants of two spin $\frac{1}{2}$ nuclei with isotropic coupling to one unpaired electron can be experimentally determined using the ENDOR technique with two radio-frequency fields in addition to the microwave field. (auth)

12087 THE PROBABILITY OF ELECTRON CAPTURE AT FIXED SCATTERING ANGLES IN H^+-H COLLISIONS. Francis J. Smith (Univ. of Belfast). Proc. Phys. Soc. (London), 84: 889-99(Dec. 1964).

The wave treatment of electron capture is used in calculations of differential cross sections for H^+-H collisions at different scattering angles and at energies between 100 ev and 2 kev. It is shown that the impact parameter treatment is inaccurate for calculations of differential capture cross sections except at high energies and large scattering angles, that is above about 5 kev when the scattering angle of the incident proton is 0.5° and above about 0.5 kev when the scattering angle is 5°. At small angles and energies the two-state wave approximation shows considerable damping of the oscillations in the probability of electron capture, in qualitative agreement with experiment. The damping due to this wave effect is compared with that due to $2p\sigma_u - 2p\pi_u$ coupling (based on calculations made by Bates and Williams in 1964), and it is shown that the wave effect causes more damping especially at low energies. The two-state wave treatment is corrected for $2p\sigma_u - 2p\pi_u$ coupling in the case of 3° scattering and compared with the experimental results of Lockwood and Everhart obtained in 1962. Closer agreement with experiment is obtained than hitherto. The effect of rainbow scattering, important at low energies and for small scattering angles, is also discussed. (auth)

12088 CONVOLUTION BROADENING OF THE FERMI EDGE IN SOFT X-RAY SPECTROSCOPY. B. Gale (National Physical Lab., Teddington, Middx, Eng.). Proc. Phys. Soc. (London), 84: 933-40(Dec. 1964).

An analytical and numerical treatment is given of the change in width of the Fermi soft x-ray emission edge produced by instrumental and physical factors. It is assumed that these can be represented by simple analytical functions and that their effect on the emission edge can be described by a convolution integral. (auth)

12089 THEORY OF THE SCHOTTKY ANOMALY FOR STRONG SPIN-LATTICE COUPLING. V. F. Sears (Oxford Univ.). Proc. Phys. Soc. (London), 84: 951-67(Dec. 1964).

The method of double-time Green functions is applied to the problem of the Schottky anomaly in the specific heat of a spin system which is strongly coupled to the lattice vibrations. The equilibrium properties of the system are investigated in a random phase approximation. The main effect of the spin-lattice interaction is found to be the anomalous dispersion of lattice waves which are coupled with the

spins. The dispersion law is essentially that found by Jacobsen and Stevens from classical equations of motion. The total entropy change associated with the Schottky anomaly is found to exceed the value R ln 2 which it would have in the absence of spin-lattice interaction. A comparison of the observed and calculated specific heats of cerium ethyl sulfate yields information about the crystalline field splitting of the ground level of the Ce^{3+} ion and about the strength of the orbit-lattice interaction. (auth)

12090 CRYSTAL OPTICS FOR VISIBLE LIGHT AND X-RAYS. P. P. Ewald (Polytechnic Inst. of Brooklyn). Rev. Mod. Phys., 37: 46-56(Jan. 1965).

The scattering elements of the crystal are assumed to act as dipoles, and for the interior of the medium the problem is that of finding a balanced or self-consistent state of optical field and dipole vibration. This is an eigenvalue problem, with the phase velocity as the eigenvalue. Its solution leads to finding the forced vibrations in a crystal with a plane surface on which an external plane wave falls and gives the theory of reflection and refraction. The physical interpretation of the various mathematical steps of the theory is stressed. A qualitative understanding is obtained of the anomalous absorption occurring for x rays near the Bragg angles (Borrmann effect). A mechanical model of this effect is discussed. (auth)

12091 IMPERFECTIONS INTRODUCED INTO A CRYSTAL BY IONIC BOMBARDMENT AND THE WANNIER EFFECT. Yu. V. Bulgakov (Karpov Physicochemical Inst., Moscow). Soviet Phys.-Solid State (English Transl.). 6: 912-14(Oct. 1964). Translated from Fiz. Tverd. Tela, 6: 1182-5(Apr. 1964).

The problem of the effect of crystal lattice imperfections on the angular distribution of atoms emitted by a single crystal during sputtering is discussed. It is shown that the direction of emergence is very important even in the cases where, as a result of defect clustering, the maximum range of focusons near the surface reduces to 6-7 lattice periods. (auth)

12092 THEORY OF THE PHONONLESS LINE BROADENING IN THE MÖSSBAUER OR OPTICAL SPECTRUM. M. A. Krivoglaz (Inst. of Metal Physics, Kiev). Soviet Phys.-Solid State (English Transl.), 6: 1340-7(Dec. 1964). Translated from Fiz. Tverd. Tela, 6: 1707-17(June 1964).

The effect of thermal vibrations on the broadening of a narrow phononless line in the optical or in the Mössbauer spectrum is analyzed. The calculations are based on the method of ordered operators. It is shown that the magnitude of the broadening, which is due to an interaction with localized vibrations, and which was analyzed in a harmonic approximation by Snyder and Wick, may be reduced by a few orders of magnitude if anharmonicity is taken into account. The form of the broadened phononless line and the temperature dependence of its width are determined in this case, and also in the case of an interaction with crystal vibrations resulting in a change of the vibrational frequencies during a phototransition. It is shown that, if the anharmonicity is taken into account, the broadening may also be due to linear terms in phonon operators in the difference between the vibration hamiltonians for the initial and final states. (auth)

12093 CALCULATION OF THE GROUND STATE ENERGY OF LITHIUM. Shou-fu Pan, Feng-wu Chang, and Tung-fa Chang. Wu Li Hsueh Pao, 20: 1058-60(Oct. 1964). (In Chinese)

The calculation of the ground state energy of Li is reviewed, taking the exchange polar effect into account. Instead of using the single Slater determinant method, the calculation is based on the simplified wave-function method. The following symmetry form was employed for the group wave function: $\psi = (\phi_1\phi_2\phi_3/\alpha\beta\alpha) + (\phi_2\phi_1\phi_3/\alpha\beta\alpha)$. On the basis of this calculation, the ground state energy of Li was found to be −14.8891. The result was compared with previous experimental data. (TTT)

12094 THE ELASTIC SCATTERING OF ELECTRONS BY NEUTRAL ATOMS AND THE EXISTENCE OF NEGATIVE IONS. T. Tietz (Univ. of Lodz, Poland). Z. Naturforsch., 19a: 1413-14(Dec. 1964).

The phase shift η_0 for the s-state in low elastic scattering of electrons by neutral atoms and the formation of negative ions are considered. An analytical expression is given for η_0. A comparison is made of results for the eigenvalues $\alpha = (2E)^{\frac{1}{2}}$ with Latter's results for α for Thomas-Fermi and Thomas-Fermi-Dirac potentials. (M.C.G.)

12095 THE ABSOLUTE INTENSITY OF THE Lα RADIATION EXCITED BY ELECTRON SCATTERING IN A THICK TUNGSTEN ANODE. W. Hink (Freie Universität, Berlin). Z. Physik, 182: 227-37(1965). (In German)

The number $N_{L\alpha}^{dir}$ of L_α-photons produced by electron-bombardment in a thick target of tungsten per incident electron was measured absolutely with the Ross-filter method and relatively with the crystal-spectrometer method in the energy-region up to the 3.6 times the L_{III}-ionization energy $E_{L_{III}}$. The result is presented in the following empirical form: $N_{L\alpha}^{dir}$ (produced) $= 4\pi \cdot t \cdot (U_0 - 1)^n$ with $t = 0.52 \times 10^{-4} \pm 5\%$ and $n = 1.44 \pm 0.02$ ($U_0 = E_0/E_{L_{III}} < 3.6$), from which the number $n_{L_{III}}$ of L_{III}-ionizations per electron which is slowed down to the energy $E_{L_{III}}$ within the target, is evaluated. The computation of $n_{L_{III}}$ from the elementary process using Bethe's non-relativistic formulae for total L_{III}-ionization cross section Q_L and energy loss $-dE/ds$ is in full agreement with experiment in the region $2 < U_0 < 3.6$, if the constants in $Q_{L_{III}}$ are chosen as follows: $B = 4E_{L_{III}}$, $b_{L_{III}} = 0.25 \cdot 5.89$. By comparison of this result for $b_{L_{III}}$ with the corresponding value of b_K in the total K-ionization cross section Q_K for copper ($b_K = 0.35 \cdot 2.26$) it is concluded that $Q_{L_{III}}$ is considerably higher than predicted by theory. The necessary correction factors as e.g., loss of L_{III}-ionizations by rediffusion of electrons and portion of indirectly produced L_α-radiation are determined for tungsten quantitatively. (auth)

12096 MEASUREMENT OF THE DRIFT VELOCITIES OF ELECTRONS AND POSITIVE IONS IN GASES. Hans Schlumbohm (Universität, Hamburg). Z. Physik, 182: 317-27(1965). (In German)

The drift velocities of electrons v_- and positive ions v_+ in gases were measured under uniform electric field conditions at E/p-values ranging from some 100 to several 1000 v/cm torr. For oxygen, nitrogen and also for acetone and benzene the velocity v_- is proportional to $\sqrt{E/p}$ whereas for methane, carbon dioxide and other organic vapors v_- is proportional to $(E/p)^\nu$ with ν between 0.5 and 0.8. The individual constants are given. A diagram shows the values v_- obtained for hydrogen. The drift velocities of the positive ions in oxygen, nitrogen, and several other gases and vapors were found to obey the square root relation v_+ proportional $\sqrt{E/p}$ at high E/p changing over to the linear relation v_+ proportional E/p which is valid in the lower E/p-region. The factors for the gases are given. By comparing the experimental results with the various theoretical approaches for the ionic mobility it is shown that at low E/p polarisation forces are governing the interaction between ions and molecules, whereas at high E/p the hard sphere model gives good agreement except for oxygen and nitrogen, in which charge exchange is the main interaction process. (auth)

12097 IONIZATION OF THE HYDROGEN ATOM BY ELECTRON IMPACT WITH EXCHANGE. V. I. Ochkur (Leningrad State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1746-50(Nov. 1964). (In Russian)

The exchange effect taken into consideration in the first approximation of the perturbation theory in a rather simple way improves considerably the agreement of theoretical and experimental results. The derived formula gives also the possibility of considering the limiting case of classical exchange scattering. (auth)

12098 IONIZATION IN THE FIELD OF A STRONG ELECTROMAGNETIC WAVE. L. V. Keldysh (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1945-57(Nov. 1964). (In Russian)

Expressions are obtained for the probability of ionization of atoms and solid bodies in the field of a strong electromagnetic wave whose frequency is smaller than the ionization potential. In the limiting case of small frequencies these expressions change into the well known formulas for the probability of tunnel autoionization; at high frequencies they describe processes in which several photons are absorbed simultaneously. The ionization probability has a number of resonance maxima due to intermediate transition of the atom to an excited state. In the vicinity of such a maximum the ionization cross section increases by several orders of magnitude. The position and width of the resonances depend on the field strength in the wave. It is shown that for optical frequencies the mechanism under consideration of direct ionization by the wave field may be significant in the case of electric breakdown in gases and especially in condensed media. (auth)

12099 A KINETIC DESCRIPTION OF THE VAN HOVE CORRELATION FUNCTIONS. M. Nelkin, J. M. J. Van Leeuwen, and S. Yip (Cornell Univ., Ithaca, N. Y.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/50, 34p. (CONF-804-7)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Kinetic equations are derived for calculating the Van Hove density correlation functions in a moderately dense classical gas. The hydrodynamical limits of the kinetic equations are briefly studied. The behavior of the correlation functions is a direct consequence of the structure of the collision integrals in the kinetic equations. Single-relaxation-time kinetic models for solution of the kinetic equations are considered. The relation between kinetic theory and neutron inelastic scattering for classical monatomic fluids in the low-density range is established. (D.C.W.)

12100 RANGE OF ELECTRON CORRELATION IN THE HELIUM ATOM. B. M. Gimarc, W. A. Cooney, and Robert G. Parr (Johns Hopkins Univ., Baltimore). 22p. (CONF-543-16)

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

For the helium atom, a new type of correlation factor is tested which has the form $1 + ch(r_{12})$ where $h(r_{12})$ is a cut-off correlation variable such that $h(r_{12}) = r_{12}$ for $0 \leq r_{12} \leq D$ and $h(r_{12}) = D$ for $D \leq r_{12} \leq \infty$, with c and D adjustable parameters. In a series of energy calculations using wavefunctions which contain both configuration interaction and cut-off r_{12} terms, it is found that, as far as the energy is concerned: (1) The correlation cusp is unimportant, and (2) The range of the Coulomb correlation effect is of the order of the atomic diameter. For very small D, the correlation energy per unit volume is calculated to be $0.048 H/B^3$. (auth)

12101 LOCALIZED EXCITATIONS IN CONDENSED Ne, Ar, Kr AND Xe. Joshua Jortner, Lothar Meyer, Stuart A. Rice, and E. G. Wilson (Univ. of Chicago). 8p. (CONF-651-13)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The emission spectra of liquid and solid Ne, Ar, Kr, and Xe bombarded by α particles were investigated in a study of the properties and behavior of localized excitations. The suggestion that trapping of the excitation by molecule formation occurs in the condensed phase is supported by the experimental observations. (H.D.R.)

12102 POSITRON ANNIHILATION IN Na AND Li SINGLE CRYSTALS. J. J. Donaghy, A. T. Stewart, J. H. Kusmiss, and D. H. Rockmore (Univ. of North Carolina, Chapel Hill). 9p. (CONF-543-10)

From American Physical Society 1964 Meeting, Philadelphia, Mar. 1964.

Positron annihilation was used to study the behavior of electrons in sodium and lithium single crystals. The positrons are emitted by a source such as ^{22}Na or ^{64}Cu and enter the metal studied, which is placed just below the positron source. The photon pairs produced by annihilation of the positron are counted in two detectors, placed on either side of the sample about 20 ft away. The equipment was arranged so that the counting rate is proportional to the area of a slice through the Fermi surface. Data are presented in graphs. It was concluded that if the Fermi surface of Na is not spherical, then it differs from a sphere by less than 2%. It was found that the distortion is about 5%. The angular correlation curves for both Na and Li differed from a parabola, but could be fitted by assuming a velocity-dependent annihilation probability of the form predicted by Kahana. (M.C.G.)

12103 HELIUM AFTERGLOW IN A FLOWING SYSTEM. C. B. Collins and W. W. Robertson (Univ. of Texas, Austin). 50p. (CONF-531-9)

From American Physical Society 1964 Southwestern Meeting, Tucson, Ariz., Feb. 1964.

Atomic Spectrum. Spectroscopic investigation of a flowing helium afterglow revealed the presence of strong lines of neutral helium. An examination of the population distribution of the excited atomic states revealed the presence of a Saha-equilibrium between the upper states and the free electrons indicating that the primary process of populating these states was the collisional-radiative recombination of He^+. A comparison of the axial variation and pressure dependence of the intensity of the emission with the He_2^+ and He^+ concentrations strengthened this conclusion. Observations were made at times from 50 – 250 μsec into the afterglow (flow velocity $\sim 6 \times 10^4$ cm/sec) in a system having a diffusion half-life for He^+ of the order of 100 μsec, an ion density of 5×10^{12}/cc, and a maximum electron temperature corresponding to ~0.15 ev. Molecular Spectrum. Spectroscopic investigation of a flowing helium afterglow revealed the presence of strong bands of He_2. An examination of the axial variation and pressure dependence of the intensity of the emission and He_2^+ concentration, as evidenced by titration, served to identify the dominant reaction populating the excited molecular states as being the collisional-radiative recombination of He_2^+. (auth)

12104 THE SELF CORRELATION FUNCTION OF REAL GASES. D. J. Sigmar (Technische Hochschule, Vienna). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/1, 24p. (CONF-804-19)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

In the formal theory of inelastic scattering of neutrons, the self-correlation function was derived in terms of statistical averages of the derivatives of the N-body interaction-potential of the scatterer. These averages are evaluated for real gases by means of a cluster expansion related to that of Mayer-Ursell. This leads to certain nonlinear types of clusters, which are investigated with respect to the topology of the graphs, their multiplicity (by combinatorial analysis), and their quadrature. As expected in view of the many-body problem, some of the clusters are not separable and have to be machine-integrated. In this way, the self-correlation function $\gamma_s(\vec{x},t)$ is calculated for short times, including also the first non-Gaussian term. The cluster expansion breaks off after the first interaction term, so that the results are valid for low density only. This still gives rise to very many different types of clusters containing up to 7 points for each coefficient. As the potential, a general two-particle hard-core type is assumed. As Singwi has shown, the long-time behavior of γ_s is determined by the time integral of the velocity-autocorrelation: $\int_0^\infty < v_x(0)v_x(t) > dt$. The integrand for all times can be constructed, using the cluster expansion for small t and adopting Langevin's stochastic theory for large T. (auth)

Cosmic Radiation

Refer also to abstracts 12051, 12052, and 12422.

12105 (AD-608345) EXPERIMENTAL OBSERVATIONS ON THE INTENSITIES OF HELIUM NUCLEI IN THE PRI-

MARY COSMIC RADIATION. P. S. Freier, G. D. Greer, J. Valdez, and C. J. Waddington (Minnesota, Univ., Minneapolis. School of Physics). Oct. 1964. Contract Nonr-710(60). 14p. (CR-72) $1.00(OTS).

The results are presented of thirteen separate observations of the characteristics of the helium nuclei in primary cosmic radiation. These observations were made using photographic nuclear emulsions flown on high altitude balloons to detect the particles during times ranging from the minimum of solar activity to the maximum. The results are compared with those published previously on the higher charged nuclei in cosmic radiation. (auth)

12106 (NASA-CR-150) COSMIC-RAY COLLISIONS IN SPACE. PART III. LOW-ENERGY PROTONS FROM COSMIC-RAY COLLISIONS IN SPACE. Final Report. M. Ferentz and S. N. Milford (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Jan. 1965. Contract NASw-699. 21p. $2.00(OTS).

The intensity of low energy cosmic ray protons produced by the collisions of higher energy cosmic ray protons with the interstellar gas is calculated. First, the physics of the high-energy elastic proton-proton collisions is used to calculate the production rate of recoil protons as a function of energy. A simple astrophysical model in which the low energy cosmic rays diffuse in an infinite interstellar medium and are removed from a given energy range by atomic slowing collisions, nuclear collisions, and sudden disappearance (corresponding to escape from our galaxy) is considered. It is found that the solutions for the cosmic ray intensity can be divided into approximate solutions for "high" and "low" energies. High energies are those for which the escape term is much more important than the slowing term, while for low energies the slowing term dominates. Second, using the diffusion model and the derived source strength, the low energy cosmic ray proton intensity is found for the energy range 0 to 500 Mev. For this single type source and diffusion model, the integral intensity above 1 Mev is about 0.02 cm^{-2} sec^{-1}. (auth)

12107 A NEW DETERMINATION OF THE EFFECT OF PHOTON JETS (LARGE JETS POOR IN MUONS). Jerzy Gawin, Roland Maze, Jerzy Wdowczyk, and Alexandre Zawadzki (Laboratoire de Physique Cosmique, Réduit de Verrières, Verrières-le-Buisson, France). Compt. Rend., 259: 3504-7(Nov. 16, 1964). (In French)

The effect of the results of a complete calculation of the density spectra of muons in photon jets on the determination of the relative frequency of these jets was analyzed. By the application of two different hypotheses on the origin of cosmic photons of very high energy, it was concluded that the adoption of each of them leads to analogous results. An experimental discrimination of these hypotheses is proposed. (tr-auth)

12108 HIGH-ENERGY NUCLEONS IN HIGH-ALTITUDE ATMOSPHERE. Kh. P. Babyan, N. L. Grigorov, E. A. Mamidzhanyan, and V. Ya. Shestoperov (Erevan State Univ.). Dokl. Akad. Nauk Arm. SSR, 38: 101-4(1964). (In Russian)

An attempt was made to determine the cosmic nucleon absorption length in the atmosphere. Ionization chambers were used at altitudes of 200 and 3250 m. The energy and intensity of the electron-photon component of the showers were determined, and the nucleon absorption length was found to be 109 ± 8 g/cm^2 for nucleons at energies $\geq 2 \times 10^{12}$ev. (C.E.S.)

12109 ENERGY DEPENDENCE OF THE COEFFICIENT OF DIFFUSION OF SOLAR COSMIC RAYS. L. I. Dorman and L. I. Miroshnichenko (Inst. of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 127-9(1964).

A quantitative investigation is made of the energy dependence of the diffusion coefficient and scattering path of solar cosmic rays. The time of maximum density of solar cosmic rays is computed for the entire energy spectrum, using a formula derived from the equation of isotropic spherical diffusion of particles on nonuniformities of the interplanetary magnetic field. These values are compared with experimentally determined values of the diffusion coefficient. It is found that the dependence of the diffusion coefficient on kinetic energy, at least for protons with energies greater than several hundred Mev, is described adequately by a power function with an exponent close to 0.7. (M.J.T.)

12110 EXISTENCE OF A SEMI-DIURNAL VARIATION IN COSMIC-RAY INTENSITY DURING A DISTURBED PERIOD. G. V. Kuklin and A. A. Luzov (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, Siberia). Geomagnetism Aeronomy, 4: 132-6(1964).

The neutron component of the world network of cosmic-ray stations was analyzed for the period from Oct. 14 to Nov. 5, 1957, which includes the period of the magnetic storm of Oct. 21 to 23. The average period of the second independent component was found to be 16.05 hr for six stations, differing from the period of semi-diurnal variation and suggesting that there is no regular semi-diurnal variation in the cosmic-ray intensity during a disturbed period. The most probable causes of irregular periodic variations in a disturbed period are found to be inhomogeneities of the corpuscular stream and incorrect assessment of meteorological effects. (M.J.T.)

12111 NON-THERMAL GALACTIC RADIATION AND THE ELECTRON COMPONENT OF COSMIC RAYS IN A NON-STEADY-STATE APPROXIMATION. G. G. Getmantsev and Yu. V. Tokarev (Gor'kii State Univ., USSR). Geomagnetism Aeronomy, 4: 189-91(1964). Translated from Geomagnetizm i Aeronomiya, 4: 243-6(1964).

On the assumption that the heavy component of primary cosmic rays is of primordial origin and that the relativistic electrons are of secondary origin, an electron energy spectrum is found for various ratios between electron T_e and heavy particle T_p lifetimes. The limiting cases $T_p \to 0$ and $T_p \to \infty$ correspond respectively to a model of the primordial origin of the electron component of cosmic rays and to a steady-state model. The results are compared with recent radio-astronomy data. (auth)

12112 COMPARISON OF VARIATION OF THE HARD COMPONENT OF COSMIC RAYS IN TIXIE BAY AND AT YAKUTSK. N. P. Chirkov (Inst. of Space Physics and Aeronomy, Academy of Sciences, Siberian SSR). Geomagnetism Aeronomy, 4: 226-9(1964). Translated from Geomagnetizm i Aeronomiya, 4: 290-4(1964).

An examination is made of seasonal and secular variations of the hard component of cosmic rays I_p and of averaged Forbush effects in I_p for the stations at Yakutsk and in Tixie Bay for 1958–1961. After correction of the observed intensity for barometric and temperature effects the variation of I_p at Yakutsk and Tixie Bay is in good general agreement. Discrepancies in January, April, and May 1960 can be explained by a difference in the amplitudes of the secular variation. The amplitudes of the Forbush effect in 1958, 1960, and 1961 coincide on average, but in 1959 were 40% greater in Tixie Bay than at Yakutsk. This can be explained by expansion of the interplanetary magnetic field in 1959. (auth)

12113 COUPLING COEFFICIENTS AND THE INTERPRETATION OF UNDERGROUND OBSERVATIONS OF COSMIC-RAY VARIATIONS. L. I. Dorman. Geomagnetism Aeronomy, 4: 314-16(1964). Translated from Geomagnetizm i Aeronomiya, 4: 402-3(1964).

Coupling coefficients used in the interpretation of underground observations of cosmic-ray variations are discussed. It is proposed that the results of previous interpretation be reconsidered because the direct calculations of the integral multiplicity of meson (μ) generation and of the corresponding coupling coefficients for underground observations, based on recent views concerning the elementary event of interaction between nucleons with allowance for ionization losses and meson (μ) decay, demonstrated that previously obtained coupling coefficients significantly overstated the role of high energies and reduced the role of low energies. (C.E.S.)

12114 ON THE DETERMINATION OF THE TRUE RADIO BRIGHTNESS DISTRIBUTION OVER AN EXTENDED COSMIC RADIATION SOURCE. A. Z. Balklav (Astrophysical Lab., Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad., Vestis, Fiz. Tek. Zinatnu Ser., No. 4, 47-52(1964). (In Russian)

A method for determination of the true distribution in a one-dimensional case is proposed using the two-antenna radiointerferometer records of the source. All the necessary numerical calculations may conveniently be carried out on a digital computer. The possibility of applying the proposed method to a two-dimensional case is also discussed. (auth)

12115 ON THE ROLE OF FLUCTUATIONS OF THE CHARACTERISTICS OF INTERACTIONS OF NUCLEAR ACTIVE PARTICLES IN DIFFERENT PROCESSES OBSERVED IN COSMIC RADIATION AT HIGH ENERGIES. N. L. Grigorov and V. Ya. Shestoperov (Moscow State Univ.). Nukleonika, 9: 307-17(1964). (In Russian)

The flux of nuclear-active particles in cosmic showers was measured 3250 meters above sea level. The integral spectrum $N(\geq E)$ decreased from 10^{-4} particles/cm^2 sec-steradian at $E = 10^{10}$ ev to 10^{-10} at $E = 10^{13}$ ev. The spectrum of gamma rays $n_\gamma(E)$ was also measured and could be fit by the curve $n_\gamma(E) = \text{const.}\ (500/E)^{0.2}$, where E is in Bev. The proportionality constant depends on the value taken for the coefficient of inelastic interaction K. The spectra of generated pions and muons were calculated from the fire-ball model. Young atmospheric showers of electrons and photons account for about half of the energy lost in the generation of mesons (π^0). Previous calculations based on ionization give particle spectra from the showers which are harder than those experimentally observed. If in addition it is assumed in the calculations that K undergoes large fluctuations, better agreement may be had with the experimental data. (TTT)

12116 PRODUCTION SPECTRUM OF π^0 MESONS PRODUCED IN INTERACTIONS OF HIGH ENERGY PARTICLES. Z. Buja, B. Heller, J. Massalski, B. Niziol, and T. Plazak (Inst. for Nuclear Research, Laboratory of High-Energy, and Mining-Metallurgical Academy, Krakow). Nukleonika, 9: 323-7(1964). (In Russian)

Gamma rays measured from 15 atmospheric showers with total photon energy in the range $(2\text{-}6) \times 10^{12}$ ev were registered by a series of ionization chambers and nuclear emulsions. The results were reduced using curves of Nishimura and Kidd for the number of electrons and gamma rays. The results are plotted as the integral spectrum $(\geq E_\gamma)$ versus $E_\gamma/\Sigma E_\gamma$, where ΣE_γ is the total energy release in the burst. The curves could be fit by $N_\gamma = \text{const.}\ E_\gamma^{-1.52}$. Pairs of photons which were produced by the same meson (π^0) decay were collected, and the spectrum of the resulting mesons (π^0) was calculated. The integral π^0 spectrum fits the curve $N_{\pi^0} = 60(10E_{\pi^0}/\Sigma E_{\pi^0})^{-1.52}$. The results are in agreement with previous measurements. A phenomenological relation between the spectrum of primary nuclear active particles and the π^0 spectrum is presented. The data are useful in resolving the nature of π^0 production at high energies. (TTT)

12117 PRODUCTION OF HIGH ENERGY γ-QUANTA IN INTERACTIONS INITIATING E.A.S. WITH ENERGIES 10^{14}-10^{15} ev IN THE UPPER PART OF THE ATMOSPHERE. R. A. Antonov, Yu. A. Smorodin, and Z. I. Tulinova (Lebedev Inst. of Physics, Moscow). Nukleonika, 9: 329-38(1964). (In Russian)

Gamma quanta with energies above 7×10^{11} ev were measured for avalanches at atmospheric pressures of 197 and 311 g/cm^2. Simultaneously the intensity of the shower was measured by registering the charged particle density at several points. The γ rays were registered by a system of 120 counters. Calculations showed that the γ quanta were generated at a height of 10^4 meters. The average number of particles per burst ranged from 7×10^4 to 1.5×10^6. The γ quanta were generated by particles with energies of 1.5×10^{14} to 3.10×10^{15} ev. The energy registered from scattered γ rays was determined to be less than $\frac{1}{3}$ of that of the original γ rays. The spectra taken at 311 and 197 g/cm^2 densities are similar, showing that most of the γ rays originate in the upper atmosphere, and that the cascade multiplication of pions introduces only a minor change in the observed spectra. The results agree with earlier data on primary cosmic rays. The energy dissipation is much higher than that predicted by the Landau theory, and agrees better with the Heisenberg fire-ball theory. (TTT)

12118 ON THE POSSIBILITY OF INVESTIGATION OF THE COMPOSITION OF ULTRA-HIGH ENERGY PRIMARY COSMIC RADIATION. N. M. Nesterova and S. I. Nikolskii (Lebedev Inst. of Physics, Moscow). Nukleonika, 9: 339-46(1964). (In Russian)

The structure of primary cosmic rays with energies above 10^{14} ev may be determined by measuring the ratio of Q, the intensity of Cherenkov radiation, to N, the number of particles detected. The method is useful because of a relatively high transparency of the atmosphere to Cherenkov radiation compared to that of electrons. It is assumed that N is proportional to E^α, and Q to E^β. Values of α and β are calculated based on various assumptions about the composition of the primary and secondary cosmic particles. The hydrodynamic model is used to calculate the secondary rays produced in collisions of primary protons, heavier nuclides, and mesons (π) with atoms of nitrogen and oxygen in air. Results of the calculations agree with data taken at the Pamir station from 1955-57. The intensity of the Cherenkov radiation is assumed proportional to the total energy loss by the particles in ionizing the atmosphere. (TTT)

12119 SEARCH FOR PHOTONS OF THE ENERGY OF 10^{13} ev DUE TO LOCAL SOURCES OF COSMIC RADIATION. A. E. Chudakov, V. L. Dadykin, V. I. Zatsepin, and N. M. Nesterova (Lebedev Inst. of Physics, Moscow). Nukleonika, 9: 347-54(1964). (In Russian)

It has been hypothesized that the high-energy electrons in sources of radioemissions are the results of the decay of mesons (π^0) which arise from interactions of cosmic rays with interstellar matter. The observation of high-energy photons in the radioemissive sources would verify the hypothesis, but detection of the photons is difficult, since their intensity is only 10^{-6} of that of the charged particles in these sources. Apparatus to detect the Cherenkov radiation from the electron components of wide atmospheric showers is described. The apparatus has an effective area of 10^5m^2 and can measure the direction of the radiation to within 1°. The bursts of Cherenkov radiation are recorded with scintillation counters in 12 parabolic mirrors. A quadrupole-coincidence circuit is used to reduce chance coincidences. In some measurements a neon light was placed in each telescope to compensate for changes in the sky light. Nine sources, including Cygnus A, Taurus A (in the Crab nebula), and Cassiopea A, were measured. Measurements were taken while the source passed through the line-of-sight of the telescope, and lasted from 80 to 200 minutes. The results showed that the flux of photons with energies over 5×10^{12} was less than 5×10^{-11} cm^{-2} sec^{-1}. The results agree with calculations based on the magnetic fields and gas densities in the sources, but disagree with the hypothesis that the electrons created in the Crab nebula are formed from nuclear collisions. (TTT)

12120 INVESTIGATION OF μ-MESON COMPONENT BY MEANS OF COMPLEX MSU APPARATUS. S. N. Vernov, G. B. Khristiansen, A. T. Abrosimov, V. V. Artashkevitch, O. V. Vedeneev, G. V. Kulikov, Yu. A. Nechin, V. I. Soloveva, Yu. A. Fomin, and B. A. Khrenov (Moscow State Univ.). Nukleonika, 9: 355-63(1964). (In Russian)

An apparatus was designed for three studies: the fluctuations in the meson (μ) flux in wide atmospheric showers to obtain data on primary cosmic radiation, the spatial distribution of mesons (μ) along the axis of the showers, and the spectra of electromagnetic radiation caused by the mesons (μ). The apparatus consists of a system of GM counters 40 meters below the earth to count the me-

sons, coupled with a series of GM and scintillation counters on the surface of the earth to measure the particle density and spectrum of the showers. The effective area of the apparatus is 45 m^2; it can measure the direction of the meson flux over a solid angle of 5–10° on the zenith and 20–30° on the azimuth. In 500 showers observed, none were observed without meson (μ) flux. The frequency distribution of total number of mesons per shower has a definite shape. The spatial distribution of the mesons is essentially independent of the total number of mesons in the shower, except that there is a greater tendency for the mesons to be concentrated at one point if the total number of mesons (μ) ranges from $1\text{-}3 \times 10^5$ than if it is greater than 4×10^5. The spatial distribution from the point of concentration varies as about $r^{-0.5}$. (TTT)

12121 μ-MESON COMPONENT IN ELECTRON-PHOTON SHOWER. S. Karakula and E. Wdowczyk (Lodz Univ., Poland). Nukleonika, 9: 377-8(1964). (In Russian)

The number of mesons (μ) in an atmospheric electron-photon shower caused by high-energy protons is estimated on the assumptions that the cross section for the photoproduction reaction is $\sigma = 0.11$ mbarn. The following multiplying factors were assumed for three different variants: $n = 2.7\ E^{0.25}$ for $E < 48$ Bev, $n = 2.3\ E$ for $E > 48$ Bev ($n = 16$), and $n = 1$, where one meson carries away the entire energy of the photon. The distribution of photons in the shower according to energy and height were taken from the Landau equations. The total number of mesons (μ) at sea level is 1300 to 1800 for a shower caused by a photon with an energy of 10^{15} ev, which is 0.8 to 1.1% of all the particles in the shower. The number of mesons (μ) in a photon shower is also compared with the number of mesons (μ) in a wide atmospheric shower as calculated from the Grayson formula. It was found that the ratio of mesons (μ) in the photon shower to the number of mesons (μ) in a wide atmospheric shower depends on the counting threshold of the equipment. The ratio $N\mu(\gamma)/N\mu(P)$ decreases with increasing energy. (TTT)

12122 BAROMETRIC EFFECTS OF PENETRATING COMPONENT OF E.A.S. AND THE RATIO OF DENSITY FLUX OF PARTICLES OF PENETRATING COMPONENT TO THE DENSITY FLUX OF ALL PARTICLES IN THE SHOWER. R. Firkowski and Z. Zawadzki (Inst. for Nuclear Research, Lodz, Poland). Nukleonika, 9: 385-7 (1964). (In Russian)

An unshielded hodoscopic array of Geiger-Muller tubes was used at 216 meters above sea level to count the particles in a shower by eight-fold coincidence counting. The penetrating component in the shower was counted by an array of 56 counting tubes shielded by 12 cm of iron and 30 cm of lead. The counting was carried out over a period of 29 months at various barometric pressures. The temperature correction was 0.8% for each 20 torrs. A plot of the natural log of the count rate in a shower versus the barometric pressure in torrs gave a straight-line dependency. The effect of barometric pressure on the penetrating component was found to be $\beta_p = -6.1 \pm 1.9\%$ for each 10 torrs. The ratio of the penetrating component to the total number of particles in the shower increases with increasing pressure. The effect of pressure on this ratio is $3.4 \pm 1.1\%$ for each 10 torrs. (TTT)

12123 POSSIBLE SOURCE MECHANISM FOR LOW-ENERGY GALACTIC ELECTRONS. Karl A. Brunstein (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 137: B757-9(Feb. 8, 1965).

A calculation is made of the expected secondary electron flux resulting from the knock-on collisions of the primary nuclear beam with the interstellar gas. The model includes ionization losses and a statistical Fermi-mechanism energy gain. Comparison is made with recent satellite experimental data. (auth)

12124 DETERMINATION OF THE K/π RATIO FROM ELECTROMAGNETIC CASCADE MEASUREMENTS. J. L. Osborne and A. W. Wolfendale (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 84: 901-9(Dec. 1964).

All available measurements of the energy spectra of electromagnetic cascades in cosmic radiation were combined to predict the muon spectrum at sea level, assuming all pions or all kaons as cascade and muon sources. Comparison was made with the muon spectrum measured directly with magnetic spectrographs and, at higher energies, inferred from underground depth intensity measurements, the ratio of production of kaons and pions in high energy interactions was derived by interpolation. Under the assumption that the energy spectra of pions and kaons have the same form, the K/π ratio is found to vary from 20 ± 20% at 2×10^4 Bev through $10^{+\frac{5}{0}}$% at 7×10^4 Bev to 40 ± 30% at the highest energy studied, 6×10^5 Bev. (auth)

12125 THE SPECTRUM OF HIGH-ENERGY COSMIC-RAY MUONS. J. L. Osborne, A. W. Wolfendale, and N. S. Palmer (Univ. of Durham, Eng. and Univ. of Nottingham, Eng.). Proc. Phys. Soc. (London), 84: 911-13(Dec. 1964).

A variety of studies was made of the energy spectrum of cosmic ray muons. For energies up to 1000 Bev magnetic spectrographs were used, and at higher energies indirect measurements were made. Inconsistencies between the results of the various experiments are reported and studied. The differences are resolved, and an estimate of the spectrum is made for the energy range 20-7000 Bev. (auth)

12126 COSMIC X-RAY SOURCES. S. Bowyer, E. T. Byram, T. A. Chubb, and H. Friedman (Naval Research Lab., Washington, D. C.). Science, 147: 394-8(Jan. 22, 1965).

Eight new sources of cosmic x rays were detected by two Aerobee surveys in 1964. One source, from Sagittarius, is close to the galactic center and the other, from Ophiuchus, may coincide with Kepler's 1604 supernova. All the x-ray sources are fairly close to the galactic plane. (auth)

Direct Energy Conversion

12127 (AD-420017) THE DEVELOPMENT OF A THERMIONIC CONVERTER MODULE SUITABLE FOR LIQUID METAL HEATING. Quarterly Technical Report No. 7. G. Y. Eastman and J. J. O'Grady (Radio Corp. of America. Special Electronic Components Div., Lancaster, Penna.). Oct. 1963. Contract AF33(657)-8005. 20p. $2.60(OTS).

Effort was continued to improve performance and increase the reliability of thermionic energy converters for space applications. The particular objectives include optimization of geometry and ceramic insulation between emitters and heat source. This work will include the development of a thermionic generator module to develop 3.0 volts of potential from a liquid metal heat source. The overall concept of the 3-volt generator was established. Before final design and fabrication of the generator, the more difficult problems are being solved by fabricating and testing prototype 3-converter modules. During this period, four 3-converter modules were assembled. A number of subassemblies were successfully tested and techniques for assembling a series of converters within a single envelope were perfected. A method of bonding the center heat source tubing was tentatively selected and materials for detailed evaluation of the method were ordered. Life testing of one Type A-1198B converter was concluded after 1010 hours. Another converter of this type completed 600 hours of a life test with a constant output of 46 watts. (auth)

12128 (AD-604827) ION CLOUD SHAPE AND POTENTIAL DISTRIBUTION IN AN ELECTRO-FLUID-DYNAMIC GENERATOR (thesis). James Robert Wifall (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). June 1964. 83p. (GAM/ME/64-22). $4.00(OTS).

The ion cloud shape and potential distribution within the conversion section of an electro-fluid-dynamic generator were investigated. Phase I of the study dealt with the investigation of a uniform electrostatic field with and without a corona discharge. The results showed that an

extremely sharp probe point is required to measure the potential of an electrostatic field and that the ion cloud, emanating from a single needle in a fluid with zero velocity, is parabolic in shape. In Phase II the conversion section was probed with a sharp pointed probe. Results showed that the flow pattern has a greater influence on the ion cloud shape than electrostatic forces, and therefore the ion cloud diverges rapidly due to the high turbulence. (auth)

12129 (ASD-TDR-62-896(Pt.II)) HIGH TEMPERATURE THERMOELECTRIC GENERATOR. C. M. Henderson, R. G. Ault, E. R. Beaver, H. B. Jankowsky, R. J. Janowiecki, and G. H. Ringrose (Monsanto Research Corp. [Dayton Labs.], Ohio). Oct. 1, 1963. Contract AF33(657)-7387. 141p. (AD-42854). $3.00(OTS).

A nominal 5-watt laboratory model generator survived a 2556-hr sustained test in a vacuum with a hot junction temperature of 1200°C and a cold junction temperature of 720°C without degradation of power output. Despite an unoptimized design and the use of only p-type thermoelectric material, this generator exhibited a 2.75 watt/lb performance. Tests were performed on high temperature p- and n-type thermoelectric materials to determine their resistance to damage from sublimation and thermal shock. Segmented p- and n-type thermoelements, capable of operating between 1200 and 500°C in a vacuum, were produced and evaluated for use in an advanced model generator. On the basis of the evaluations made on the segmented thermoelements, a nominal 50-watt advance experimental model generator was designed, fabricated, and preliminarily tested. (auth)

12130 (GEST-2042) RESEARCH AND DEVELOPMENT PROGRAM OF THERMIONIC CONVERSION OF HEAT TO ELECTRICITY. Quarterly Technical Summary Report No. 1. (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Oct. 30, 1964. Contract NObs-90417. 10p.

Development work on series-connected thermionic assemblies intended for use in a nuclear fuel element is discussed. Information is included on: the design of the first prototype, thermal and stress analysis, and techniques for fabrication, assembly, and testing of the prototype. (N.W.R.)

12131 (IRD-64-36(Pt. 1)) RESEARCH PROGRAMME ON MAGNETOPLASMADYNAMIC POWER GENERATION. PART 1. MPD CLOSED-LOOP. Technical Summary Report, December 1, 1962–March 31, 1964. B. C. Lindley (International Research & Development Co. Ltd., Newcastle-upon-Tyne, England). Contract N62558-3127. 256p. (AD-602381). $6.00 (OTS).

High-temperature commissioning of the closed-cycle helium-cesium MPD loop occupied about twelve months with a total of about 2000 hours of circuit operation, of which 300 hours were at temperatures up to 2500°K with unseeded helium. The commissioning phase of the loop development program culminated in cesium-seeded operation and electric power generation. In these initial experiments the loop was operated continuously for fifteen hours with gas temperatures up to 2020°K. Twenty series of measurements were made, with varying temperature, cesium content and applied magnetic field, extracting a maximum power output of 0.46 we from a five-electrode-pair constant-area generator. Electrical conductivities of about 0.5 mho/m were obtained at static gas temperatures below 1500°K. The loop technology and operation was proved. (auth)

12132 (IRD-64-36(Pt. 2)) RESEARCH PROGRAMME ON MAGNETOPLASMADYNAMIC POWER GENERATION. PART 2. PLASMA PHYSICS. Technical Summary Report, December 1, 1962–March 31, 1964. B. C. Lindley (International Research & Development Co. Ltd., Newcastle-upon-Tyne, England). Contract N62558-3127. 26p. (AD-602382). $3.00(OTS).

Presented are: microwave studies of thermally-excited plasmas; an atomic beam experiment; microwave studies of photoionization and recombination; electrical conductivity studies; photoionization studies in MPD generators; cross section measurements and transport properties in seeded-inert-gas MPD generators; and electrical-conductivity and breakdown in studies in cesium vapor. (auth)

12133 (FTD-TT-64-103) THEORETICAL PRINCIPLES OF THE MHD GENERATOR. Zdzislaw Celinski. Translated from Przeglad Elektrotech., 37: 353-8(1961). 18p. OTS.

A simplified theory of a MHD generator with a fixed gas flow and a constant external magnetic field is outlined. (C.E.S.)

12134 RESEARCH IN THERMIONIC ENERGY CONVERSION. D. L. Dresser, D. R. Zimmerman, and J. D. Dunlop. Allison Res. Eng., 3: 11-29(1964). Dunlop. Allison Res. Eng., 3: 11-29(1964).

The physics of thermionic energy conversion is reviewed, with descriptions of the vacuum thermionic converter, the Cs thermionic converter, modes of operation, and performance. Surface physics studies on refractory metal emitter materials— Ta, W, and Re— are discussed. The design, fabrication, and operation of a flexible laboratory thermionic converter developed for research studies are described. Results are reported on converters with W and Re emitters; typical data are given for electron-emission, ion-emission and arc-mode characteristics. (M.J.T.)

12135 ECONOMIC IMPLICATIONS OF MPD POWER GENERATION. B. C. Lindley (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.). Energy Intern., 1: 18-21(Nov. 1964).

Magnetoplasmadynamic (MPD) system concepts are described, and progress towards the development of large-scale MPD electric power stations is reviewed. The economics and market possibilities for MPD power generation indicate that combined MPD-steam systems are the most promising for large-scale production of electricity. (H.D.R.)

12136 THERMIONIC A-C GENERATION. C. L. Eisen and A. Schock (Republic Aviation Corp., Farmingdale, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Commun. Electron., 83: 260-6(May 1964).

A system for modulating the output of a thermionic generator and delivering a high-voltage alternating current to the load is presented. After optimizing the mode of operation, equations for the maximum conversion efficiency are derived. For a given anode work function and cathode temperature, it is shown that for sinusoidal output the maximum a-c efficiency is equal to approximately 70% of the corresponding d-c value. (auth)

12137 THE INFLUENCE OF WALL CONDUCTANCE ON MAGNETOHYDRODYNAMIC CHANNEL-FLOW HEAT TRANSFER. W. T. Snyder (State Univ. of New York, Stony Brook). J. Heat Transfer, 86: 552-8(Nov. 1964).

An analysis is made of the influence of finite electric conductivity of the walls on fully developed magnetohydrodynamic channel-flow heat transfer. The analysis is based on arbitrary external electrical loading and is thus valid for both generator and accelerator modes of operation. Constant properties of the fluid and walls are assumed. It is shown that under certain operating conditions of external electrical loading, the fluid bulk to wall temperature difference for conducting walls differs substantially from that for electrically insulating walls. Representative numerical calculations are presented. (auth)

12138 COMBINED CYCLE MHD POWER GENERATION. Mituyoshi Yamamoto and Takuma Tamaoki (Tokyo Shibaura Electric Co., Ltd.). Nippon Kikai Gakkai Rombunshu, 30: 636-44(May 1964). (In Japanese)

In open-cycle MHD generators operated by combustion gas, only thermal ionization in equilibrium is employed to make the gas conductive, where the initial temperature of the working gas must be over 3000°C and the efficiency, when combined with steam turbine generators, is expected to be approximately 55%. On the other hand, in closed-cycle

systems operated by monoatomic gas, it is possible to use nonequilibrium conduction by elevating only electron temperature and to reduce the initial temperature of the gas, alleviating the difficulties of high temperature materials. The overall thermal efficiency of a relatively low-temperature MHD generator combined with a given steam power plant is discussed in connection with the effects of operating parameters of the MHD generator. It is concluded that at the initial temperature of about 2000°C it is possible to get almost the same efficiency as that obtainable at a higher temperature. (auth)

12139 PROPULSION OF SUBMARINES BY LORENTZ FORCES IN THE SURROUNDING SEA. S. Way (Westinghouse Research Labs., Pittsburgh). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/ENER-7, 8p, $1.00. (CONF-763-11)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The field configuration for external magnetohydrodynamic propulsion of a submarine, using longitudinal exciting conductors, was analyzed. The electrode size may be optimized to yield maximum efficiency. Exciters are assumed to be superconductors. The efficiency is improved by using a smaller number of electrodes (and exciters) but the stray field is thereby amplified. A good compromise seems to be with 14 to 16 electrodes. With 14 electrodes a 5000 metric ton submarine would be propelled at about 29 knots with 15840 kw of electrical power, the propulsive efficiency being 50%. At 19.4 knots the efficiency becomes 60%. This is for the case of peak (critical) field at the superconductor surface of 70,000 gauss. The stray field falls, in this case, to 0.01 gauss at 3 hull diameters removed from the hull surface. Gases evolved by electrolysis will generally be less than half a liter for each lineal meter of the wake, and are therefore considered inconsequential. A submarine of the type considered, having no moving propeller blades, external ductwork or other flow encumbrances, would glide through the water with a minimum of disturbance and noise. (auth)

12140 MAGNETOAERODYNAMIC CONVERSION PIPES OF HIGH POWER IN THE SUBATMOSPHERIC REGIME. G. Klein, P. Dubois, and G. Nocton (Compagnie Générale d'Electricité, Marcoussis, France). 9p. (CONF-640701-7). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Results obtained in the calculation of two series of MGD generators are reported. In the first series the subatmospheric conversion pipe is placed immediately behind the combustion chamber and an accelerating pipe; in the second it is behind a primary conversion pipe operating above atmospheric pressure with a magnetic field of 5 Teslas. The available electric power from both were determined. (J.S.R.)

12141 OPEN-CYCLE MAGNETOAERODYNAMIC CONVERSION PIPES AT HIGH POWER AND INTENSE FIELD. G. Klein, P. Dubois, and G. Nocton (Compagnie Générale d'Electricité, Marcoussis, France). 9p. (CONF-640701-8). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The method followed and the principal results obtained in studies on the dimensioning of open-cycle magnetoaerodynamic generators are indicated. The generators considered were characterized by a flow of heavy fuel No. 2 corresponding to a thermal power of 1000 Mw and a magnetic field of 5 Teslas. The pressure at the output of the conversion tube is sufficient to allow the injection of burned gases without recompression. It was established that a considerable fraction of the available thermal energy is transformed into electrical energy in the conversion tubes by the order of magnitude of the electrical energy that would be available in the absence of all installations for energy recovery behind the magnetoaerodynamic conversion tube. (J.S.R.)

12142 CONTRIBUTION TO THE RESEARCH OF OPTIMUM MHD POWER PLANTS. G. Mondain-Monval (Société L'Air Liquide, Paris). 11p. (CONF-640701-40). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The characteristics of the MHD converter and the yield of a MHD power plant are calculated and the results are reported. (J.S.R.)

12143 CONVERSION IN THE INHOMOGENEOUS JET. EXPERIENCE OF MODULATION OF TEMPERATURE BY THE JOULE EFFECT IN COMBUSTION GASES. R. Devime (Institut Francais du Petrole, Rueil-Malmaison, France), H. Lecroart, and P. Zettwoog. 11p. (CONF-640701-2). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The results of experiments with the creation of a jet with temperature modulation produced electrically are reported. The principle of the modulation apparatus and the experimental installation are described. The results showed that temperature modulation is possible on a combustion gas, the modulation is conserved for a period of time, and the stability of this modulation needs to be determined. (J.S.R.)

12144 MHD GENERATOR USING GAS SUPERHEATED BY SHOCK WAVES. Eric Brocher and Aymar Lefrancois (Battelle Memorial Inst., Geneva). 17p. (CONF-640701-3). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The utilization of shock waves of moderate intensity to elevate the temperature of a preheated gas in order to generate electricity by MHD was investigated. It is shown that the shock waves are an efficient means, thermodynamically speaking, of increasing gas temperature although the increase during the passage of a shock wave is not more than 2. A thermodynamic cycle containing shock waves and a MHD generator was studied. The yield of this cycle was compared to that of a conventional cycle and the conditions when the first is superior to the second are given. (J.S.R.)

12145 HETEROGENEITIES AND INSTABILITIES IN MAGNETOHYDRODYNAMIC GENERATORS. A. Békiarian and Z. Croitoru (Electricité de France, Paris). 6p. (CONF-640701-104). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The consequences of heterogeneities on the performance of a MHD generator with respect to the useful power and the electric yield were analyzed. The conditions under which these heterogeneities can develop in a generator were determined. The results are tabulated. (J.S.R.)

12146 THE CONDITIONS OF RECOVERY OF PARIETAL LOSSES IN AN OPEN CYCLE MHD INSTALLATION. J. Péricart (Electricité de France, Paris). 16p. (CONF-640701-6). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The problems connected with the transmission of heat through walls, its evacuation by a heat-carrying fluid, and its reutilization are stated and examined. The study is schematic and only shows the principal problems: the heat flux to be evacuated, heat transmission through the walls, evacuation of the heat, and recovery of the heat. (J.S.R.)

12147 STUDY OF THE PROCESSES OF MAGNETOAERODYNAMIC CONVERSION UTILIZING SUBATMOSPHERIC COMBUSTION GASES. G. Klein, P. Dubois, and A. Dubois (Compagnie Générale d'Electricité, Marcoussis, France). 11p. (CONF-640701-4). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The most important characteristics of open-cycle subatmospheric generators are presented. The geometry of the conversion tube is defined and the temperature of the combustion gas and recoverable enthalpy was determined. Charge losses in the tube and thermal losses at the walls are considered. The parameters of the generator with Hall effect are reported. The characteristics of a 1 Mw(t) gen-

erator were calculated. Some practical uses for such generators are listed. (J.S.R.)

12148 OBTENTION OF AN INHOMOGENEOUS MHD JET BY COMBUSTION OF A MIXTURE OF PREMODULATED COMPOSITION AND TEMPERATURE. C. Karr (Commissariat à l'Energie Atomique, Petrole, France and Institut Francais du Petrole, France). 10p. (CONF-640701-1). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The method of obtaining an inhomogeneous jet by premodulation and combustion is described. The conditions of mass transfer, quantity of movement, and heating between zones were studied by attempting to define their relative importance and the values of the jet parameters for which they are minimum. (J.S.R.)

12149 THE POSSIBILITIES OF UTILIZATION OF THE PHENOMENON OF NON EQUILIBRIUM IONIZATION IN CLOSED CYCLE MAGNETOHYDRODYNAMIC GENERATORS. Z. Croitoru (Electricté de France, Paris). 9p. (CONF-640701-103). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Equations expressing the characteristics of an ionized gas seeded with K and exposed to a static magnetic field are given. Curves representing the electron temperature, gas pressure, gas temperature, seeding rate, effects of impurities, and the nature of the gas were calculated from the basic equations. The results were applied to the case of MHD generators to explore the utility of this phenomenon to the operation of closed cycle MHD generators. (J.S.R.)

12150 DESIGN STUDY OF SOLAR BRAYTON CYCLE CAVITY RECEIVERS WITH LITHIUM FLUORIDE HEAT STORAGE. R. A. McKinnon (Thompson Ramo Wooldridge Inc., Cleveland), T. J. Vild, and J. A. Milko. New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-727, 30p. $1.00. (CONF-640901-12)

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1964.

Thermal energy storage methods and performance are examined for solar power conversion systems. Heat storage materials, including lithium hydride, lithium fluoride, sodium fluoride, and several oxide mixtures, are investigated to determine their potential application in power systems. Results of materials corrosion tests are presented. The basic design concept is developed for a solar Brayton cycle cavity receiver using argon gas as the working fluid and lithium fluoride heat storage. (H.D.R.)

12151 ESTIMATE OF SOLAR-THERMIONIC SYSTEM PERFORMANCE. W. Menetrey (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-718, 28p. $1.00. (CONF-640901-7)

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1964.

At the present time, photovoltaic arrays are the predominant means for supplying power to a spacecraft. A leading competitor for many future applications are solar-thermionic systems. A discussion is presented of the general performance expected from a solar-thermionic system in about 1970. By this time, it will be possible to have operational solar-thermionic systems in a variety of sizes depending upon application and effort placed in development. A weight comparison is drawn between photovoltaic panels and solar-thermionics in spacecraft operations which range from Mars to Mercury. As shown, solar-thermionic systems weight compares favorably with the weight expected for photovoltaics; definite weight advantages occur in sun probe missions which travel close to the sun. (auth)

12152 CHARACTERISTICS OF GAS-ELECTRODE CONTACTS IN THE CASE OF THERMAL IONIZATION. P. Ricateau (Commissariat à l'Énergie Atomique, Saclay, France). 9p. (CONF-640701-91). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Gas conductors intervening in MHD conversion are characterized by a pressure close to atmospheric pressure and some ionization produced by seeding. The ionization is governed by the energy of the electrons with a Maxwellian distribution. The electrical phenomena appearing in seeded plasma when it is traversed by a current introduced by two plane electrodes in the absence of a magnetic field were studied. The structure of the region affected by the proximity of the electrode was examined in order to determine the effects on the electric characteristics between the electrodes. (J.S.R.)

12153 STUDY OF THE PERFORMANCE OF AN OPEN-CYCLE MHD GENERATOR AS A FUNCTION OF THE MAGNETIC FIELD AND THE LOSS OF PARIETAL HEAT. J. Péricart and A. Houyez (Electricité de France, Paris). 19p. (CONF-640701-5). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

A study was made on the performance of a mixed installation containing an open-cycle MHD power plant in association with a steam power plant. The effects of the rate of superoxygenation of the combustion air, the conversion factor of the MHD pipe, and the electrical yield of the MHD pipe on the performance were determined. The study was completed by a determination of the effects, on the total yield, of the magnetic excitation field and of the heat losses from the walls along the length of the NHD converter. The results showed that a mixed power plant with a conventional electromagnet of 2.3 Teslas could lead to an acceptable yield (48 to 49%) even for relatively high wall losses if the corresponding heat is correctly recovered. In the case of a electromagnet with reduced or zero losses, yields approaching 55% could be obtained but the investment costs might limit the use of this type of cycle. (J.S.R.)

12154 EXPERIMENTAL RESULTS ON THE PHENOMENA OF NON EQUILIBRIUM IONIZATION IN MHD GENERATORS. Z. Croitoru, A. Bekiarian, R. Graziotti, and M. Pithon (Electricite de France, Paris). 7p. (CONF-640701-97) (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The use of segmented electrodes in MHD tubes causes difficulty because of the necessity of sufficient insulation between the segments, that is, the temperature of the insulant must be moderated, but the electrodes can not be too cold or there will be too great a drop in potential at the gas contact. A good compromise between these contradictory conditions was experimentally studied. The experimental installation used, flow characteristics, design of the MHD tube, and measurement devices are described. The results showed that some effects of ionization without equilibrium seemed to have been obtained in the presence of a magnetic field, but less than expected. The major difficulty appeared to be in obtaining the Hall effect by electric fields because of the imperfection of the insulation. (J.S.R.)

12155 THE CLOSED CYCLE MHD CONVERSION INSTALLATION OF THE COMMISSARIAT A L'ENERGIE ATOMIQUE. P. Zettwoog (Commissariat à l'Énergie Atomique, France), and L. Le Blan. 11p. (CONF-640701-51). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The closed cycle MHD conversion installation of the CE is briefly considered. The bellows and the purification and recycling systems are described. The material and technolological problems caused by work at high temperature in the presence of Cs are discussed. The problems of purification of the helium and cesium before reintroduction and the MHD installation associated with the bellows and its exploitation are described. (J.S.R.)

12156 ON THE PRODUCTION OF INHOMOGENEOUS JETS USABLE IN MGD. R. Marchal and P. Servanty (S.N.E.C.M.A., Paris). 8p. (CONF-640701-26). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The study, fabrication, and testing of a gas generator usable in MGD was undertaken. The theoretical and practical interest in periodic combustion is defined. The design of the single and two-stage generators is indicated. The measurements and their results on the temperature of operation, yield and pressure of the gases, and the instantaneous temperature of the gas and walls are reported. The general conclusion on the operation and functioning of the acoustical resonance type generator and the convergent-divergent type is summarized. (J.S.R.)

12157 THE ECONOMIC POSITION OF MHD FOR CENTRAL POWER. A. E. Weller and William T. Reid (Battelle Memorial Inst., Columbus, Ohio). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/ENER-1, 15p, $1.00. (CONF-763-23)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Technical and economic obstacles are discussed from the standpoint of fluid mechanics, fuels utilization, and energy conversion processes that must be resolved before MHD systems can be made economically operational. An absolute projection of each competing technology based on past developments and known scientific principles was used to assess the future economic potentialities of MHD central-station power. Various proposed MHD schemes were examined, and the technological problems associated with their realization were isolated. (P.C.H.)

12158 CURRENT-VOLTAGE RELATIONS FOR A HIGH-PRESSURE THERMIONIC CONVERTER. M. R. El-Saden (North Carolina State Univ., Raleigh). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/ENER-6, 8p, $1.00. (CONF-763-32)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An analysis based on the assumption that the interelectrode spacing consists of a neutral plasma separated from the electrodes by sheaths of charge carriers is presented. Five significant regions are recognized in the analysis; the two electrodes, the two sheaths, and the neutral plasma. The currents of the species in each region are discussed and are all expressed in terms of the saturation thermionic current of the emitter and the random currents from the plasma. The four modes of operation that arise when one or both electrodes are either negative or positive relative to the plasma are covered. Expressions for the charge density in the two sheaths were developed. When the latter are used with Poisson's equation, the potential distributions in the two sheaths can be determined. (auth)

12159 HIGH-VOLTAGE ELECTROGASDYNAMIC GENERATORS. M. P. Khan (Curtiss-Wright Corp., Wood-Ridge, N. J.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/ENER-11, 12p, $1.00. (CONF-763-33)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The promises and limitations of the use of the interaction of an electric field and a gas flow with charged particles as a means of extracting electrical power is considered analytically on the basis of a simple one-dimensional model. Three nondimensional parameters, initial interaction parameter N_1, ratio of initial drift velocity to flow velocity D_1, and initial charge density to electric field ratio K_1 are formed, and their influences on the performance were obtained. In analyzing this process three restricting conditions were observed. They are the choking considerations, electric field direction, and the drift velocity. It was found that the turbine efficiency mainly depends on the mobility of the charged particles represented by the parameter D_1. For colloidal charged particles the turbine efficiency is 90% or greater. For higher conversion ratios, both for colloidal and molecular ions, the desired electric field is approximately constant and this requires a decreasing charge density, according to the results of the analysis. The output voltage is higher for molecular ions than for colloidal ions, for the same initial charge density, i.e., parameters N_1 and K_1. The characteristics of EGD generators are high voltage and low current density, since charges of only one polarity are used. (auth)

Elementary Particles and Radiations

Refer also to abstracts 11387, 11663, 12380, and 12574.

12160 (ARL-64-187) BASIC EQUATIONS OF THE RELATIVISTIC TEST PARTICLE PROBLEM. S. P. S. Anand (Yale Univ., New Haven). Oct. 1964. Contract AF33(657)-7271. 14p. (AD-609590). $1.00(OTS).

From a completely covariant formulation, the general equations that describe density and velocity distribution as well as the electromagnetic field induced by a charged particle in the surrounding fluid are derived. Linearization is introduced, but the possibility of an external magnetic field is excluded. It is shown that it is of little importance whether the test particle is relativistic or not, as long as the ensemble's mean thermal speed is small compared with the speed of light. (auth)

12161 (CERN-65-3) ON THE GENERALIZATION OF THE ISOPARITY. L. C. Biedenharn, J. Nuyts, and H. Ruegg (European Organization for Nuclear Research, Geneva). Jan. 11, 1965. 51p. Dep.(mn).

The generalization of the isoparity (G parity) to internal symmetry groups which belong to any of the four families of compact simple and simply connected Lie groups is explicitly carried out. The extended isoparity is shown to depend upon the structure of the groups in question, and the required structure is developed in detail. The properties of the extended isoparity are discussed, and two cases—strong G parity and weak G parity—are shown to arise. The relation between the isoparity extension and superselection rules is briefly discussed, and a concluding section illustrates, by example, the possibility of other extensions available in direct products. This example is of intrinsic interest since, for example, it allows an internal (symmetry) distinction between meson and baryon octets that excludes meson decuplets. (auth)

12162 (COO-1428-7) PRODUCTION OF $\Sigma^+ K^+$ BY π^+, p INTERACTIONS AT 1111 Mev/c, 1206 Mev/c, AND 1265 Mev/c. N. L. Carayannopoulos, G. W. Tautfest, and R. B. Willmann (Purdue Univ., Lafayette, Ind.). [1963]. Contract AT(11-1)-1428. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The reaction $\pi^+ + p \rightarrow \Sigma^+ + K^+$ was studied at incident pion momenta of 1111, 1206, and 1265 Mev/c in the liquid hydrogen bubble chamber. The cross section for this process was found to be 144 ± 10 μb at 1111 Mev/c, 214 ± 15 μb at 1206 Mev/c, and 278 ± 20 μb at 1265 Mev/c. Decay assymmetries gave values of α^+P^- of $-0.16 \pm .15$, $0.05 \pm .14$, and $0.30 \pm .14$, and values of α^0P^- of $0.50 \pm .13$, $0.37 \pm .13$, and $0.68 \pm .12$ at 1111, 1206, and 1265 Mev/c, respectively. The angular distribution of the Σ^+ hyperons and α^0P as a function of the Σ^+ production angle are presented at each of the three momenta, along with the results of partial wave analyses based on these distributions. (auth)

12163 (JINR-P-1829) UNITARNAYA SIMMETRIYA I LEPTONNYE RASPADY STRANNYKH CHASTITS. (Unitary Symmetry and Leptonic Decays of Strange Particles). I. V. Chuvilo (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 29p. Dep.(mn).

This review describes recent progress in weak interactions of elementary particles on the basis of SU(3) symmetry. The consequences of theoretical considerations are compared with experimental data. (auth)

12164 (JINR-P-1860) O VOZMOZHNOSTI OBEE-BINENIYA GRUPPY LORENTSA S GRUPPOI UNITARNOI SIMMETRII. (On a Possibility of Combining the Lorentz

Group and the Unitary Symmetry Group). E. Kapustsik and E. Obryk (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 5p. Dep. (mn).

One of the possible ways of combining the inhomogeneous Lorentz group and the SU_3 group into one 18-parametric Lie group is discussed. By assuming that the generators corresponding to the operators of the total isotopic spin and its third component commute with those of the total spins, its third component, and the four-momentum, we obtain that all the commutators of the Lorentz group generators and those of the SU_3 generators are equal to zero. (auth)

12165 (JINR-P-1886) ASIMPTOTICHESKIE SOOTHOSHENIYA MEZHDY SECHENIYAMI ROZHDENIYA BARIONN'KH REZONANSOV. (Asymptotic Relations Between the Production Cross Sections for Baryon Resonances). Nguen Van Kh'eu, K. V. Rerikh, and A. A. Khelash'ili (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 6p. Dep.(mn).

The asymptotic equality of the cross sections for the crossing inelastic processes involving the production of baryon resonances has been proved. The consequences of isotopic invariance have been also treated. (auth)

12166 (JINR-P-1889) NEKOTORYE SLEDSTVIYA PRIMENENIYA TEORII UNITARNOI SIMMETRII K SISTEMATIKE SIL'NOVZAIMODEISTVUYU-SHCHIKH CHASTITS. (Some Consequences of Applying the Unitary Symmetry Theory to the Systematics of Strongly Interacting Particles). K. S. Marish (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 3p. Dep.(mn).

A new possibility of grouping the vector mesons is pointed out in the framework of unitary symmetry. Several particles having the identical quantum numbers, Y, T, and J^P have been found experimentally not only among bosons, but among baryons as well. (auth)

12167 (NEVIS-124) MUON DEPOLARIZATION IN SOLIDS (thesis). Bob Einsenstein (Columbia., Irvington-on-Hudson, N. Y. Nevis Labs.). May 1964. Contract Nonr-266(72). 63p. (CU-230; AD-606475; R-427)

When polarized positive muons stop in a solid, they may be depolarized prior to their decay. The presence of a magnetic field along the direction of initial polarization will inhibit, or quench, some of this depolarization. Depolarization and quenching were studied in a variety of solids, including semiconductors, at temperatures as low as 4.2°K. No evidence was found that any muon depolarization is associated with the formation of a muonium atom which is bound for $> 10^{-10}$ sec, even in samples at 4.2°K For many samples and temperatures, the quenching of the observed depolarization is consistent with a model in which the muon captures and loses electrons repeatedly forming a succession of briefly bound muonium atoms. In some of the semiconductors at low temperatures, as well as in other samples, a large fraction of the depolarization is quenched by a field of 100 G. This is seen as evidence for another depolarization mechanism. (auth)

12168 (NP-14540) STRUCTURE ELECTROMAGNETIQUE DES NUCLEONS. (Electromagnetic Structure of Nucleons). R. Laverriere (Lyon. Université). [1963]. 31p. Dep.(mn).

The definition and properties of form factors and their theoretical and experimental determination were summarized on the basis of a bibliographic study. (J.S.R.)

12169 (UCRL-2426(Vol.III)(1965 Rev.)) HIGH-ENERGY PARTICLE DATA. VOLUME III. KINEMATICS OF PARTICLES AS A FUNCTION OF MOMENTUM. W. Peter Trower (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1965. Contract W-7405-eng-48. 114p. Dep.; $4.00(OTS).

The kinematic quantities T, $(\gamma-1)$, $H\rho$, β or $(1-\beta)$, and $P\beta$ are shown as functions of particle momentum for common elementary particles. The dynamic quantities $\pi\lambda^2$, ηM_p, β or $(1-\beta)$, η, $(\gamma-1)$, and w are shown as functions of incident-particle momentum for common elementary particles interacting with a proton. The particles Σ^-, Σ^0, Ξ^0, and n were not plotted, being so close in mass to one of the particles that has been included that they cannot be distinguished graphically. Only reactions of the form $M_1 + M_2 \rightarrow M_3 + M_4$ are considered, and of these possible cases only that in which M_2 is at rest and bombarded by M_1 with a momentum P_1 is discussed. (auth)

12170 (UCRL-7874-T) TOPICS IN SCATTERING THEORY. I. FORMAL THEORY OF SCATTERING. Malcolm H. MacGregor (California. Univ., Livermore. Lawrence Radiation Lab.). May 1964. Contract [W-7405-eng-48]. 184p. Dep.(mn); $5.00(cy), 3(mn) OTS.

Notes are presented from a course on scattering theory. (auth)

12171 (UCRL-7874(A)-T) TOPICS IN SCATTERING THEORY. II. NONRELATIVISTIC THEORY OF REGGE POLES. Malcolm H. MacGregor (California. Univ., Livermore. Lawrence Radiation Lab.). May. 1964. Contract [W-7405-eng-48]. 103p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Notes are presented from a course on scattering theory. The notes were compiled from the published literature and from several standard reference books. (auth)

12172 (UCRL-11650) FORTRAN PROGRAM KINE—CALCULATING KINEMATICAL AND DYNAMICAL QUANTITIES FOR PARTICLE INTERACTIONS AND DECAYS. W. Peter Trower (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 3, 1964. Contract W-7405-eng-48. 22p. Dep.(mn); $2.00(cy), 1(mn) OTS.

FORTRAN program KINE is a calling routine for a collection of seven subroutines. Each subroutine calculates interesting kinematical and dynamical quantities for the particle reaction $1 + 2 \rightarrow 3 + 4$ by applying special relativity to the process in the form of the Lorentz transformation. The reaction is completely specified if, in addition to the rest masses involved, two of the physical variables are specified. The subroutines perform calculations for the most useful combinations of these two variables. (auth)

12173 (WL-TDR-64-78) A LEAST-SQUARES METHOD FOR THE ANALYSIS OF PROTON-PROTON SCATTERING DATA. David J. Knecht (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Nov. 1964. 95p. (AD-610004). $4.00(OTS).

A detailed method is developed for the analysis of low-energy proton-proton scattering experiments. Convenient formulas for the differential scattering cross section and for the polarization are derived from the scattering amplitudes, and a completely analytic least-squares method is derived for fitting the theoretical expression to the experimental data. Contributions to the cross section from scattering in the S, P, and D states are included; contributions from tensor and spin-orbit forces are included in addition to those from central forces. The effects of vacuum polarization, of scattering in states of higher angular momentum, and of coupling between states of same J but different L are not computed by inclusion in the scattering amplitudes, but provision has been made to include these effects when calculated separately. The treatment is relativistically correct, but does not include dynamic relativistic effects, which are negligible at low energy. Two FORTRAN computer programs are presented; the first makes the least-squares analysis to derive phase shifts from the experimental scattering data, while the second evaluates the theoretical expressions for the cross section and polarization for given values of the phase shifts. The estimation of uncertainties in the derived phase shifts is discussed in some detail. (auth)

12174 EVIDENCE AGAINST EMISSION THEORIES. J. G. Fox (Carnegie Inst. of Tech., Pittsburgh). Am. J. Phys., 33: 1-17(Jan. 1965).

The Ritz theory of electromagnetism and optics is criticized in the light of experimental evidence, after the introduction of a simple modification of the hypothesis concerning the velocity of radiation scattered by the electrons of

medium. It is argued that the theory is then in harmony with the electron theory of dispersion and accounts satisfactorily for aberration, the first-order Doppler effect from moving sources, and interferometer experiments on binary stars. There is no evidence from binary stars which contradicts it. It is compatible with the second-order Doppler effect and possibly the Fizeau experiment, since it is argued that these phenomena depend essentially on the momentum and energy of radiation. Other phenomena are discussed. It is concluded that the best evidence against the theory comes from experiments on the lifetimes of fast mesons and the velocity of γ rays and light from moving sources. (auth)

12175 SCATTERING OF WAVE PACKETS. Eyvind H. Wichmann (Univ. of California, Berkeley). Am. J. Phys., 33: 20-31(Jan. 1965).

The elastic scattering of spinless particles from a spherically symmetric stationary target is considered. The incident particle beam is described as a statistical ensemble of one-particle wave packets, and the differential cross section is defined in terms of the average scattering of the particles in this ensemble. The physical significance of this mode of description is discussed, and arguments are presented as to why it should be regarded as a realistic description of typical scattering experiments. The discussion is general and not restricted to potential scattering. It is based on the notion of the S matrix, and the most basic ideas of the S matrix are discussed. A simple derivation of the partial wave expansion is given within the framework of S matrix theory. (auth)

12176 BIBLIOGRAPHIC STUDY ON THE POSSIBLE DIFFERENT STATES OF THE 4-NUCLEON SYSTEM. Jean-Claude Jacmart (Universite de Paris, Orsay, France). Ann. Phys. (Paris) (13), 9: 553-6(Sept.-Oct. 1964). (In French)

The excited states of ^{4}He and the existence of ^{4}H and the tetraneutron ^{4}n are discussed on the basis of a bibliographic study. The experimental and theoretical data available are summarized. (J.S.R.)

12177 HYPERCHARGE AND THE U_2 GROUP. W. Królikowski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw and Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 573-5(1964).

It is pointed out that the U(2) group — the group of unitary transformations in two complex dimensions — is necessary and sufficient to define the hypercharge and derive the Gell-Mann — Nishijima formula for the charge. Relations between the operators of the U(n) and SU(n) groups are derived. Formulas for the isospin, charge, and hypercharge in the U(2) group are given, and the Gell-Mann — Nishijima formula is obtained from them. (M.J.T.)

12178 THE TWO VIRTUAL PHOTON PROCESS AND WILLIAMS-WEIZSACKER COVARIANT METHODS. Jean-Claude Le Guillou (Université, Paris). Compt. Rend., 259: 2793-6(Oct. 28, 1964). (In French)

By using the gauge invariance and the vectorial nature of the photon, the existence, in the two-virtual-photon process of the type considered, of five "form factors" for the cross section was shown. The covariant versions of Gribov and of Gorgé of the Williams-Weizsacker approximation methods were then generalized for these processes. (tr-auth)

12179 A HYPOTHESIS OF MOTT AND MASSEY CONCERNING THE ASYMPTOTIC FORM OF ONE SOLUTION OF AN INTEGRAL EQUATION FOR A THREE-BODY SCATTERING PROBLEM. Luc Dagens (Commissariat a l'Energie Atomique, Paris). Compt. Rend., 259: 2797-8 (Oct. 28, 1964). (In French)

It is shown that the Mott and Massey integral equation for the scattering of a particle by a bound two-particle system (in which one is identical to the incident particle) admits an infinity of solutions that does not verify the Mott and Massey hypothesis on the asymptotic form of the exchange term. (tr-auth)

12180 THE HIGH MASS AND ELECTROMAGNETIC FORMULAS OF ELEMENTARY PARTICLES. Moshe Flato and Joeel Sternheimer (Institut Henri-Poincaré, Paris). Compt. Rend., 259: 3455-8(Nov. 16, 1964). (In French)

By grouping experimentally known particles phenomenologically according to their spin J^P, a mass formula for baryons and mesons is proposed. A possible theoretical explanation is suggested by utilizing the unification procedure of Lie algebras, which describe the external (Poincaré) and internal symmetries. (tr-auth)

12181 ON THE THEORY OF THE ELECTRON. Walter Wessel (Universität, Heidelberg). Fortschr. Physik, 12: 409-40(1964).

In studies on the theory of the electron, an attempt was made to remove, by a limited increase of the mechanical degrees of freedom of the moving charge, the divergences of quantum electrodynamics originating in the infinite number of degrees of freedom of the frequency space. The investigations led to infinite representations of the Lorentz transformation. In these representations the Dirac equation was replaced by one that entails replacement of Dirac's linear mass term by a third-order mass operator of the Heisenberg type. Equations of motion in the classical theory, Hamiltonian and Poisson brackets, quantum theory representations, an invariant wave equation and its applications, origin of the mass operator, parity conservation and four velocity, and "run-away" motion and "Zitterbewegung" are discussed. (M.C.G.)

12182 INVARIANT IMBEDDING AND TIME-DEPENDENT SCATTERING OF LIGHT IN A ONE-DIMENSIONAL MEDIUM. Richard Bellman, Robert Kalaba, and Sueo Ueno (RAND Corp., Santa Monica, Calif.). J. Math. Anal. Appls., 9: 424-32(Dec. 1964).

The invariant-imbedding technique is used to derive the integral equations for the coefficients of reflection and transmission of radiation by a one-dimensional homogeneous medium of finite optical thickness. Two characteristic time scales are considered — the Dirac delta-function time-dependent case and the unit step-function time-dependent case. The reflected and transmitted intensities from the medium, illuminated by a unit step-function time-dependent pencil of radiation from outside, are expressed in terms of these coefficients. (M.J.T.)

12183 VARIATIONAL SCATTERING BY NUCLEAR POTENTIALS. C. Joachain (Université Libre, Brussels). Nucl. Phys., 64: 529-47(Apr. 1965).

The Schwinger variational principle for the scattering amplitude is applied to the study of various nuclear potentials, which constitute significant tests of its validity. Detailed numerical calculations are performed for the $^3S_1$ neutron-proton interaction. First, the exponential and Gaussian potentials are examined, and it is found that Schwinger's formulation is a precise approximation method in a very large energy region. Then, it is proved that for any nonlocal but separable potential the fractional form of Schwinger's variational principle gives the exact scattering amplitude. The Yamaguchi potential is treated as an example. In each case, comparison with first and second Born approximations is made. (auth)

12184 A MODEL OF WEAK INTERACTIONS MEDIATED BY SCALAR BOSONS. W. Kummer and G. Segrè (CERN, Geneva). Nucl. Phys., 64: 585-92(Apr. 1965).

By introducing two new neutral leptons, two massive scalar bosons, and a new absolutely conserved quantum number, an attempt is made to formulate a renormalizable theory of the weak interactions. (auth)

12185 RADIATIVE EFFECTS IN ELECTRON-ELECTRON COLLISIONS. V. M. Galitskii and S. A. Kheifets (Inst. of Physics, Academy of Sciences, Novosibirsk, USSR). Nucl. Phys., 64: 629-35(Apr. 1965).

An experiment in electron-electron scattering in the c.m. system is considered. Scattering angle and radiative energy distributions are obtained. (auth)

12186 CHECK OF DISPERSION RELATIONS IN THE REGION OF SMALL ANGLES AND HIGH ENERGIES. V. S. Barashenkov (Joint Inst. for Nuclear Research, Dubna, USSR) and V. I. Dedju. Nucl. Phys., 64: 636-40(Apr. 1965).

The real parts of the amplitude for elastic $\pi^{\pm}-p$, $p-p$ and $\bar{p}-p$ scattering through zero angle are calculated on a computer with the aid of dispersion relations. A comparison of the results of the calculation with the available experimental data shows that no essential deviations from the dispersion relations in the energy range $T \lesssim 20$ Bev, i.e., up to distances $R \approx 0.06$ fm are observed within the accuracy of the measurements. (auth)

12187 CALCULATION OF NUCLEON FORM FACTORS THROUGH THE GREEN FUNCTION APPROXIMATION SCHEME. P. Narayanaswamy and A. N. Mitra (Univ. of Delhi). Nucl. Phys., 64: 641-51(Apr. 1965).

The photon-pion-nucleon system is studied by a non-perturbative approximation method based on the truncation of covariant Green functions in field theory. The prescription of spectral representations is used to incorporate correct analyticity requirements. The anomalous magnetic moments and mean square charge radii of the nucleon calculated by this approximation method are an improvement over perturbation theory. The results are compared with those of dispersion theory. (auth)

12188 LOW-ENERGY PHOTONS IN ELEMENTARY PARTICLE COLLISIONS. L. D. Soloviev (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 64: 657-76 (Apr. 1965).

General equations of local field theory (including quantum electrodynamics in all orders in e) were used to obtain the first two terms in the series expansion of the bremsstrahlung matrix element in the momenta of the soft photons. For bremsstrahlung of one photon with momentum k the first term of this expansion is of order k^{-1}, the second one is of order $e^2 \ln k$, and the third term is independent of k. The coefficients of the first and second terms are proportional to the matrix element for the corresponding process without emission of the soft photons. With the aid of this expansion the first two terms in the series expansion of the bremsstrahlung cross section in the radiated energy are obtained; a term of order $k^2 \ln k$ in the series expansion of the total cross section for scattering of a photon with momentum k by a charged particle is found. It is shown that the imaginary part of the elastic Compton scattering amplitude at fixed momentum transfer is a generalized power function of the energy s near the threshold $s = m^2$; the first term in the expansion of the amplitude in powers of $s - m^2$ is found and the next term is estimated. It is shown that the factorization of infrared divergences of any scattering amplitude follows from simple physical considerations and the spectral condition. (auth)

12189 THE PARTIAL WAVE AMPLITUDE FOR HIGH-ENERGY PION-PION SCATTERING. [PART] III. P. Olesen (Universitetets, Copenhagen). Nucl. Phys., 64: 685-93(Apr. 1965).

An approach to the high-energy behavior of the partial wave amplitudes $A_l^I(s)$ was previously developed, and it was found that $A_l^I(s)$ decreases logarithmically with the energy. The high-energy parameter γ_l^I, defined through $A_l^I(s) \to i\,[\gamma_l^I \log s]^{-1}$ for $s \to \infty$, is investigated as a function of l and I. It is possible to express γ_l^I entirely in terms of low-energy parameters (which in principle can be obtained from experiments). The behavior for $l \to \infty$ of γ_l^I is investigated in a simple model, where the low-energy region is so small that it only contains the S-wave resonance ω_{ABC}. It turns out that l/γ_l^I decreases exponentially and that γ_l^I is entirely due to isospin zero exchange; γ_l^I is independent of I. (auth)

12190 THEORY OF LOW ENERGY SCATTERING BY VELOCITY DEPENDENT POTENTIALS. B. H. J. McKellar and R. M. May (Univ. of Sydney). Nucl. Phys., 65: 289-93(May 1965).

Low energy scattering by pure velocity dependent potentials is investigated. It is found that the potential $V_1 = (2m)^{-1}\, p \cdot U(r) p$ gives a phase shift of order k^{2l+1} except in S states where the phase shift is of order k^5, while the potential $V_2 = (4m)^{-1}\,[p^2 W(r) + W(r) p^2]$ gives a phase shift of order k^{2l+3}. A nonvanishing scattering length may be restored by including a static potential, but to simulate a hard core exactly this potential must have properties which are not usually assumed in attempts to fit the scattering data with velocity dependent potentials. The difference between V_1 and V_2 is also a static potential, but again this is not of the form usually assumed. The analysis yields a linear integral equation for the coefficient of k^{2l+3} in scattering by V_2, but in general a nonlinear equation for the leading coefficient in scattering by V_1. For this potential however the coefficient of k^5 in S-wave scattering is given by a closed expression. (auth)

12191 GRAPHICAL REPRESENTATION OF LORENTZ TRANSFORMATION FOR THE EMISSION ANGLES AND MOMENTUM OF RELATIVISTIC PARTICLES. E. G. Bubelev. Nukleonika, 9: 409-16(1964). (In Russian)

A graphical method is presented for solving the relativistic-particle kinematics in velocity space on the Lobachevsky plane, and mapping the results onto a Euclidean strip. The result is isomorphic with a Lorentz transformation. The method is applied to solve for the emission angle θ and the momentum p when the rest mass m is greater than zero, and for θ only when $m = 0$. When $m = 0$ the solution for p is a special case. The errors in the method range from 2 to 6%. It is similar to the method given by Chernikov, who used a conformal transformation from velocity space to a Euclidean sphere; however with the present method no nomograms or tables are required. The method is most useful in cases where use of a computer is impractical. (TTT)

12192 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION OF PROTON-DEUTERON SCATTERING AT 155 Mev. K. Kuroda, A. Michalowicz, and M. Poulet (Université de Paris, Orsay, France). Phys. Letters, 13: 67-8(Nov. 1, 1964). (In French)

The differential cross section of proton-deuteron scattering was measured using the 155-Mev proton beam of the Orsay synchrocyclotron. The energy resolution was of the order of 1 Mev for protons detected at small angles under the experimental conditions used. Measurements were made between 3 and 56° laboratory for the scattering protons. The results obtained were graphed and compared with the previous experimental study of Postma and Wilson at 146 Mev and with the theoretical curve of Benoist and Gomez-Gimeno. The agreement between the experimental studies and the theoretical results up to about 130° in the center-of-mass system is good. (J.S.R.)

12193 THEORETICAL INTERPRETATION OF ELASTIC NUCLEON-DEUTERON SCATTERING AT 155 Mev. P. Benoist-Gueutal and F. Gomez-Gimeno (Faculte des Sciences, Orsay, France). Phys. Letters, 13: 68-9(Nov. 1, 1964). (In French)

The calculation of the elastic nucleon-deuteron scattering at 155 Mev was undertaken on the following hypotheses. The isotopic spin of the nucleons was introduced, and the scattering amplitude in the center-of-mass system was considered to be completely antisymmetrized. The direct term was treated in the impulse approximation and the pick-up term in Born approximation. The scattering matrix was calculated in the spin space of the 3 nucleons. The D state of the deuteron was considered. The results were in good agreement with experiment up to 130° in the region where the direct term is predominant. In the pick-up region a cross section about 2 times too large was obtained. Preliminary calculations were started on proton polarization. (J.S.R.)

12194 BRANCHING RATIOS IN η MESON DECAY. F. Pauli and A. Muller (CEN, Saclay, France). Phys. Letters, 13: 351-2(Dec. 15, 1964). (In French)

The results on the calculations of the branching ratios $R_1 = (\eta \to \pi^+\pi^-\gamma)/(\eta \to \pi^+\pi^-\pi^0)$, $R_2 = (\eta \to \text{neutrals})/(\eta \to \pi^+\pi^-\pi^0)$, and $R_3 = (\eta \to \text{neutrals})/(\eta \to \text{charged particles})$

are reported. The criteria used for the selection and adjustment of the events are discussed. The results obtained are $R_1 = 0.73 \pm 0.25$, $R_2 = 3.8 \pm 1.1$, and $R_3 = 2.2 \pm 0.35$. (J.S.R.)

12195 PHENOMENOLOGICAL ANALYSIS OF SINGLE AND DOUBLE HYPERFRAGMENTS. F. Beck and U. Gutsch (Technische Hochschule, Darmstadt, Ger.). Phys. Letters, 14: 133-6(Jan. 15, 1965).

An extension is made of the numerical results obtained by Dietrich et al. in the independent pair approximation, including a different core radius, S-shell double hyperfragments, and a comparison with recent Λ-nucleon scattering data. (L.B.S.)

12196 A POSSIBLE EXPLANATION FOR $K \to 2\pi$ DECAYS WITHOUT CP VIOLATION. H. J. Lipkin (Argonne National Lab., Ill.) and A. Abashian. Phys. Letters, 14: 151-3(Jan. 15, 1965). (COO-1195-26)

It is pointed out that the observed long lived decay mode $K \to 2\pi$ can be explained by assuming the existence of a new particle, another K^0 meson which is degenerate in mass with the ordinary K^0. The proposed explanation requires no CP violation, supports recent experiments and the anomalous regeneration results of Leipuner et al., and can be tested by further measurements of the $K \to 2\pi$ decay at different target distances and different momenta. The properties of this particle are examined. (L.B.S.)

12197 A SPECULATION CONCERNING THE APPARENT CP VIOLATION IN K^0 DECAY. J. L. Uretsky (Argonne National Lab., Ill.). Phys. Letters, 14: 154-6 (Jan. 15, 1965).

It is assumed from observations on equations for the two states describing the decay of K^0 with almost definite masses and definite lifetime, K_1 and K_2, that CP is strictly conserved in weak decays. The equations exhibit the primary consequence of CP conservation that a measurement of the lifetime associated with the $K_0 \to 2\pi$ at long times may give a result very different from the known lifetime of the K_2. Addition implications of the equations are discussed, and a third neutral particle, L_0, of K-mass is considered. (L.B.S.)

12198 THE P_{11} PION-NUCLEON PHASE SHIFT — A RESONANT STATE AT 1400 Mev? R. H. Dalitz (Oxford Univ.) and R. G. Moorhouse. Phys. Letters, 14: 159-62 (Jan. 15, 1965).

It is pointed out that phase-shift analyses of pion-nucleon scattering data by Roper, Anvil et al., and Bransden et al., all of which conclude that the P_{11} amplitude is large in the energy region around 1400 Mev and that the P_{11} partial wave is responsible for the observed enhancement, give quite similar results for the P_{11} scattering and that the enhancement observed is not necessarily identified with a resonant state. The analyses appear to differ considerably in the real part $\delta(P_{11})$ of the P_{11} phase shift. (L.B.S.)

12199 LOW-MOMENTUM INTERACTIONS OF Σ HYPERONS WITH PROTONS. H. G. Dosch, R. Engelmann, H. Filthuth, V. Hepp, E. Kluge, and A. Minguzzi-Ranzi (Universität, Heidelberg). Phys. Letters, 14: 162-3(Jan. 15, 1965).

Measurements of 71 Σ^+p interactions produced in the 80-cm Saclay hydrogen bubble chambers by low-energy K^- beams from the CERN proton synchrotron are reported. Elastic scattering ($\Sigma^+p \to \Sigma^+p$), charge exchange scattering ($\Sigma^-p \to \Sigma^0n$), and inelastic interactions ($\Sigma^-p \to \Lambda^0n$) were analyzed and cross sections were found. (L.B.S.)

12200 ABSOLUTE MEASUREMENTS OF PROTON-PROTON SMALL-ANGLE ELASTIC SCATTERING AND TOTAL CROSS SECTIONS AT 10, 19 AND 26 Gev/c. G. Bellettini, G. Cocconi, A. N. Diddens, E. Lillethun, J. Pahl, J. P. Scanlon, J. Walters, A. M. Wetherell, and P. Zanella (CERN, Geneva). Phys. Letters, 14: 164-8(Jan. 15, 1965).

A high precision experiment was performed for studying the range of small-angle proton-proton elastic scattering, extending into the Coubomb region. Differential cross sections were measured using thin-plate sonic spark chambers in an arrangement of magnetic spectrometers; scintillation counter experiments with the same geometrics gave the p−p total cross sections at 10, 19, and 26 Bev/c proton momenta. The results were analyzed using the Coulomb interference and singlet-triplet models. Substantial deviations above the optical theorem value for the forward elastic scattering cross section were found. (L.B.S.)

12201 EVIDENCE FOR A WEAK R INVARIANCE FOR NONLEPTONIC HYPERON DECAYS. Ettore Remiddi and Dino Zanello (Scuola Normale Superiore, Pisa, Italy). Phys. Rev., 137: B634-5(Feb. 8, 1965).

The predictions of R invariance for Λ_- and Ξ^- nonleptonic decays were checked by a χ^2 test with the present experimental situation. Very poor agreement was found. Weaker forms of R invariance were then considered, by imposing R invariance on only one of the two invariant amplitudes of the above decays, and analogous computations were performed. The consistency of these weaker requirements with the triangular relation $\sqrt{3}\Sigma_0^+ + 2\Xi^- + \Lambda_- = 0$ was also checked. Very encouraging results were obtained. (auth)

12202 POSSIBLE ELECTRIC DIPOLE MOMENT OF NUCLEONS. G. Feinberg and H. S. Mani (Columbia Univ., New York). Phys. Rev., 137: B636-7(Feb. 8, 1965).

It is noted that the existence of a four-nucleon weak interaction which violates T invariance and P invariance would lead to a nucleon electric dipole moment which is of first order in the Fermi coupling constant. The observation of such a moment is therefore not necessarily evidence for intermediate bosons. (auth)

12203 LEPTONIC DECAY OF POLARIZED Ω^- PARTICLES. V. De Santis (Northwestern Univ., Evanston, Ill.). Phys. Rev., 137: B645-7(Feb. 8, 1965).

A previous calculation of the leptonic decay of the $^3/_2^+$ Ω^- particle assuming the most general interaction is extended to the case of a polarized Ω. The differential rate is given and the angular distribution of the Ξ is calculated for the decay $\Omega^- \to \Xi^0 + e + \bar{\nu}$. It is found to depend on three parameters that can be experimentally determined. (auth)

12204 DIRAC MAGNETIC POLES FORBIDDEN IN S-MATRIX THEORY. Daniel Zwanziger (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev., 137: B647-8(Feb. 8, 1965).

The residue of the one-photon exchange pole in the amplitude for the scattering of massive particles is calculated, using only generalized unitarity and the correspondence of particles to representations of the proper inhomogeneous Lorentz group. It is found that magnetic monopole coupling results in a residue which contains square-root singularities. Such a nonanalytic term is incompatible with the analyticity assumptions of S-matrix theory, and if it were present, the photon would appear in the annihilation channel as an intermediate state in all partial waves instead of only one. This behavior is theoretically implausible and discourages further experimental search for magnetic monopoles. (auth)

12205 FINAL-STATE INTERACTION IN THE PRESENCE OF ABSORPTION. Roland Omnes (Univ. of California, Berkeley). Phys. Rev., 137: B649-52(Feb. 8, 1965). (UCRL-11601)

There is by now a good agreement between the distorted-wave approximation and the sharpening of the peripheral peak by competing processes, although the theory itself has not been correctly derived at high energy. It is shown that the main result of the distorted-wave approximation can be derived by applying the dispersion theory of final-state interactions to the eigenstates of the S matrix. Some assumptions about the mean values and the variation of the eigenphase-shifts that fit with scattering experiment have to be made. The theory does not apply to low angular momenta. It is valid in nuclear physics. (auth)

12206 INTERNAL AND SPACE-TIME SYMMETRIES. Ulf Ottoson, Arne Kihlberg, and Jan Nilsson (Chalmers Univ.

of Tech., Goteborg). Phys. Rev., 137: B658-66(Feb. 8, 1965).

To account for the observed multiplet structure and the mass relations among the known elementary particles, a coupling of internal and space-time properties is considered. Earlier attempts in this direction have failed. The problem is re-examined from a more general point of view, and it is found that under these more relaxed conditions a coupling is possible and nontrivial mass relations may be obtained. The coupling can be described as a minimal internal coupling, which essentially consists of a replacement of the original generators of the inhomogeneous Lorentz group. The characteristic features of the mass formula are exhibited in a simple model. A number of questions related to the interpretation of such quantities as mass and energy are raised. (auth)

12207 APPROXIMATE METHOD FOR DETERMINING THE ELASTIC-SCATTERING AMPLITUDE FOR STRONG INTERACTIONS. D. W. Schlitt (Univ. of Maryland, College Park). Phys. Rev., 137: B666-71(Feb. 8, 1965).

A method for calculating the elastic-scattering amplitude in the S-matrix theory of strong interactions is proposed which does not require a partial-wave expansion of the amplitude. Crossing symmetry is satisfied by the amplitude, but unitarity is imposed only approximately. Equations are derived for the case of scattering of two spinless particles of unequal mass. The special case where the masses are equal is considered in detail for the input assumption that the scattering is predominantly S wave. Crossing symmetry introduces higher partial-wave contributions to the amplitude. The amplitude calculated in this way is in good agreement with the input assumption. The amount of violation of unitarity is least near threshold, but is only on the order of a percent at $s = 8m^2$. In spite of this, there are serious problems with low-energy resonances and bound states. It is concluded that both unitarity and crossing symmetry are important in the production of resonances and bound states and that the modification of either may lead to difficulties. The total cross section derived from the approximate amplitude is compared with that obtained using the partial-wave expansion and keeping only the S wave. The results are in good agreement with each other. (auth)

12208 EVIDENCE THAT THE DEUTERON IS NOT AN ELEMENTARY PARTICLE. Steven Weinberg (Univ. of California, Berkeley). Phys. Rev., 137: B672-8(Feb. 8, 1965).

If the deuteron were an elementary particle then the triplet n–p effective range would be approximately $-2r/(1-Z)$, where $R = 4.31F$ is the usual deuteron radius and Z is the probability of finding the deuteron in a bare elementary-particle state. This formula is model-independent, but has an error of the order of the range $m_\pi^{-1} = 1.41F$ of the n-p force, so it becomes exact only in the limit of small deuteron binding energy, i.e., $R \gg m_\pi^{-1}$. The experimental value of the effective range is not of order R and negative, but rather of order m_π^{-1} and positive, so Z is small or zero and the deuteron is mostly or wholly composite. (auth)

12209 PRODUCTION OF $K\bar{K}$ IN AN ELECTRON-POSITRON COLLIDING BEAM. Barbara Barrett and Tran N. Truong (Columbia Univ., New York). Phys. Rev., 137: B679-81(Feb. 8, 1965). (TID-21166)

Because the width (3 Mev) of the ϕ resonance is narrow and its mass (1020 Mev) is just above the threshold for $K\bar{K}$ production, the cross section for the process $e^+ + e^- \rightarrow K + \bar{K}$ is greatly enhanced at a center-of-mass energy near the mass of the ϕ. At this resonant energy it is estimated that $\sigma(e^+e^- \rightarrow K^+K^-) = \sigma(e^+e^- \rightarrow K^0\bar{K}^0) = 6.9 \times 10^{-30}$ cm^2 which is two orders of magnitude larger than the e^+e^- elastic, muon pair, and pion pair cross sections. Because of this dominant cross section, the small width of ϕ, and the fact that the ϕ mass is well below the threshold for producing an extra pion, the possibility of producing an intense beam of K_2^0 of well-defined, known momentum is suggested. New experiments might become feasible; in particular, determination of the branching ratio of the charged to the neutral two-pion decay mode, and accurate measurement of spectra and polarization in leptonic decay, which provide means of detecting CP-violating effects. (auth)

12210 THREE-FIELD MODEL AND HIGHER SYMMETRY GROUP W_3 WITH PARITY INTERCHANGE. R. E. Marshak, N. Mukunda, and S. Okubo (Univ. of Rochester, N. Y.). Phys. Rev., 137: B698-708(Feb. 8, 1965). (UR-875-55)

A theory of hadrons (strongly interacting particles) based on the higher symmetry group $W_3 = U_3 \otimes U_3$ (or $SW_3 = SU_3 \otimes SU_3$) with parity interchange between the two U_3 (or SU_3) groups was developed. The four-fermion vector model with three massless Dirac fields was used to guide the construction of the meson and baryon particles. A parity doublet structure in the W_3 (or SW_3) limit is found for the mesons but not for the baryons. Mass relations between scalar (axial vector) and pseudoscalar (vector) octets or nonets of mesons are derived under various assumptions concerning the underlying group, the tensorial behavior of the symmetry-breaking terms, and the particle representations. Some experimental tests of these mass relations are noted. The possibility of incorporating the leptons into the theory is discussed. (auth)

12211 SOME SPECULATIONS CONCERNING HIGH-ENERGY LARGE MOMENTUM TRANSFER PROCESSES. Tai Tsun Wu and C. N. Yang (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B708-11(Feb. 8, 1965). (BNL-8584)

It is speculated that the sharp decrease with increasing energy of differential cross sections at large angles is due to a mechanism independent of the method of excitation. Some consequences of such a possibility are discussed. (auth)

12212 UNCOUPLED-PHASE METHOD IN THE MULTI-CHANNEL N/D FORMALISM. Pran Nath and G. L. Shaw (Stanford Univ., Calif.). Phys. Rev., 137: B711-16(Feb. 8, 1965).

The uncoupled-phase method is a nonperturbative formalism, developed by Ross and Shaw, relating the scattering amplitudes describing n strongly coupled two-body channels to the uncoupled amplitudes describing n-1 channels alone. The uncoupled scattering amplitudes are defined to be those that would exist if the couplings to the nth channel were switched off while the interactions among the n-1 channels remain unchanged. The uncoupled-phase method, previously based on the potential model, is extended to the relativistic problem by considering a set of n coupled N/D partial-wave dispersion relations. For the situation in which the left-hand cut is approximated by the form $g/s(s + m)$ where g is an $n \times n$ matrix of constants and s is square of the total energy in the center-of-mass system, the uncoupled-phase method is exact. The quantitative validity of the uncoupled-phase method for more complicated left-hand singularities is tested by performing a two-channel computer experiment. A full numerical solution of the coupled integral equations for the N functions is obtained by the matrix-inversion technique. The situations in which the left-hand cut is replaced by a set of dipoles and the left-hand cut is assumed to be given by exchange of a scalar particle in the corresponding crossed t channel of any given reaction are considered. The coupled-phase method is found to be quantitatively accurate under a wide range of conditions. The range parameter of the coupled-phase method is directly given by a principal-value integral, and an estimate of it can be made a priori. (auth)

12213 SOLUTION OF A BETHE-SALPETER EQUATION. Charles Schwartz (Univ. of California, Berkeley). Phys. Rev., 137: B717-19(Feb. 8, 1965).

The Bethe-Salpeter equation arising from a ϕ^3 theory is solved numerically for several energies (bound states only) and symmetry states. The method used is a variational calculation in the four-dimensional Euclidean space arrived at by the transformation due to Wick. A high degree of accuracy is achieved by using only a very small amount of common computing machine capabilities. (auth)

12214 REAL PART OF THE SCATTERING AMPLITUDE AND THE BEHAVIOR OF THE TOTAL CROSS SECTION AT HIGH ENERGIES. N. N. Khuri and T. Kinoshita (Rockefeller Inst., New York and Columbia Univ., New York). Phys. Rev., 137: B720-9(Feb. 8, 1965). (TID-21172)

Certain theorems first pointed out by Meiman are used to include the information contained in analyticity in energy and crossing symmetry in the derivation of upper bounds for the forward scattering amplitude. Theorems relating the asymptotic behavior of the ratio of the real part to the imaginary part of the forward amplitude on the one hand, to that of the total cross section on the other, were obtained. Except for the special case where $Ref/Imf \sim \pi(\ln E)^{-1}$ as the incident laboratory energy $E \to \infty$. It is found that the Froissart bound can be improved. It is also found that the Greenberg-Low bound which follows from axiomatic field theory can always be improved by a fractional power of E under the physical assumption that the amplitude does not become purely real as $E \to \infty$. As a result of the theorems it is found that the asymptotic behavior $Ref \sim cE$ is not allowed. This sheds light on the question of the elementary nature of vector mesons. An inequality is given which, in principle, could lead to an experimental check of analyticity and crossing with data obtained only from a finite range of energy. (auth)

12215 HIGH-ENERGY GAMMA-RAY SOURCE FROM ELECTRON-POSITRON PAIR ANNIHILATION. Yung-Su Tsai (Stanford Univ., Calif.). Phys. Rev., 137: B730-9 (Feb. 8, 1965). (SLAC-PUB-45)

Problems associated with the use of the process $e^+ + e^- \to 2\gamma$ as a source for high-energy γ rays are investigated. The polarization of the γ's is shown to be negligible at high energies. The spread of γ spectra at a fixed angle due to radiative corrections is investigated. Terms like $(\alpha/\pi)\ln^2(4E^2/m^2)$ are associated with infrared divergence and disappear with a reasonable energy resolution. The result is very similar to Schwinger's corrections without vacuum polarization. The result was found to be also usable in the colliding-beam experiment without any modification, under certain conditions. (auth)

12216 EXPERIMENTAL TEST OF BARYON CONSERVATION AND NEUTRINO FLUX LIMITS. W. R. Kropp, Jr., and F. Reines (Case Inst. of Tech., Cleveland). Phys. Rev., 137: B740-51(Feb. 8, 1965).

An experiment was performed in which events not directly attributable to cosmic rays or natural radioactivity were observed for 4500 h in a 200-liter liquid scintillation detector. Shielding from cosmic rays was obtained through anticoincidence techniques and by locating the detector 585 m underground. Background from natural radioactivity was reduced by placing high-energy requirements on acceptable events. The residual signal was used to establish new lower limits on the stability of nucleons and a new upper limit on the product of the cross section and the electron neutrino (ν_e,$\bar{\nu}_e$) flux whatever its origin, providing its energy is <400 Mev and >30 Mev (ν_e) or >12 Mev ($\bar{\nu}_e$). Depending on the assumed decay modes, nucleon lifetime limits in the range 0.6×10^{28} to 4×10^{28} years were obtained. The upper limits on the neutrino cross section flux products are $<8.5 \times 10^{-38}$ $\bar{\nu}$e sec^{-1} and $<3.2 \times 10^{-38}$ $\bar{\nu}$e sec^{-1}. (auth)

12217 EFFECT OF ELECTROMAGNETIC CORRECTIONS TO LOW-ENERGY NUCLEON-NUCLEON SCATTERING ON CHARGE INDEPENDENCE. R. E. Schneider and R. M. Thaler (Case Inst. of Tech., Cleveland). Phys. Rev., 137: B874-7(Feb. 22, 1965).

The low-energy nucleon-nucleon scattering lengths are calculated, taking into account the electric charge and magnetic-moment distributions of the nucleons. Corrections in the one-pion exchange part of the effective nuclear interaction due to the charged and uncharged pion mass difference are also included. The singlet proton-proton, proton-neutron, and neutron-neutron scattering lengths are calculated and compared with experiment. These corrections reduce the discrepancy to be explained by other effects in order to maintain charge independence. It is concluded that recent measurements of the neutron-neutron scattering length do not contradict the hypothesis of charge independence. (auth)

12218 EXACT MULTIPLE-SCATTERING ANALYSIS OF LOW-ENERGY ELASTIC K^--d SCATTERING WITH SEPARABLE POTENTIALS. J. H. Hetherington and L. H. Schick (Univ. of Minnesota, Minneapolis). Phys. Rev., 137: B935-48(Feb. 22, 1965). (COO-1371-9)

A calculation of the K^--d low-energy elastic-scattering cross sections is carried out with the intent of determining the importance of multiple scatterings. Under the assumption that the two-body interactions are S-wave nonlocal separable potentials of the Yamaguchi form, an expression for the scattering amplitude in terms of a set of one-dimensional integral equations for each partial wave is derived. The derivation does not take into account Coulomb forces or the n-p and K^--$\bar{K}^0$ mass differences. A transformation from real to complex dummy variables that allows a rapid numerical computation of the solution to the integral equations for the scattering amplitude is presented and discussed. With the use of the Humphrey and Ross kaon-nucleon scattering lengths, the elastic angular distribution and cross section, as well as the total cross section, are calculated for incident kaon lab momenta of 105, 194, and 300 Mev/c. The results of the multiple-scattering calculation for the elastic cross section are two to three times smaller than the impulse approximation results throughout this momentum range. The multiple-scattering corrections to the impulse approximation for the total cross section are small ($\lesssim$10%) only at the largest momentum used. (auth)

12219 NON-REGGE TERMS IN THE VECTOR-SPINOR THEORY. S. Mandelstam (Univ. of California, Berkeley). Phys. Rev., 137: B949-54(Feb. 22, 1965). (UCRL-11686)

The vector-spinor theory is examined to find whether there are any Kronecker-delta terms in the angular-momentum plane or, in other words, to find whether all particles are on Regge trajectories. It was previously shown in lowest-order perturbation theory that a remarkable cancellation resulted in the vanishing of the Kronecker-delta term from the spinor channel. This conclusion is re-established by general reasoning which is independent of perturbation theory. The channel with the quantum numbers of the vector particle is examined, and here there is no cancellation. The vector particle is not on a Regge trajectory. It is concluded that the absence of Kronecker-delta terms in the j plane may still be used as a criterion for a bootstrap system. (auth)

12220 APPROXIMATE SOLUTIONS TO PARTIAL-WAVE DISPERSION RELATIONS. G. Q. Hassoun and Kyungsik Kang (Univ. of Michigan, Ann Arbor). Phys. Rev., 137: B955-61(Feb. 22, 1965).

The partial-wave dispersion relations of the scattering amplitude are considered by means of the inverse amplitude technique. The sense in which the N/D and inverse amplitude methods of solution are equivalent is discussed. A method of solution that is symmetric and free from subtraction parameters is given. The procedure is illustrated for the $\pi\pi p$ bootstrap problem for the single-channel case. A self-consistent solution is obtained. (auth)

12221 EXPERIMENTAL STUDY OF PARTICLE PRODUCTION AT SMALL ANGLES IN NUCLEON-NUCLEON COLLISIONS AT 19 AND 23 Gev/c. D. Dekkers, J. A. Geibel, R. Mermod, G. Weber, T. R. Willitts, K. Winter, B. Jordan, M. Vivargent, N. M. King., and E. J. N. Wilson (CERN, Geneva). Phys. Rev., 137: B962-78(Feb. 22, 1965).

Differential cross sections are presented for the production of pions, kaons, protons, and antiprotons at the angles 0 and 5.7°, produced in proton collisions with H_2, Be, and Pb targets at primary momenta of 18.8 and 23.1 Bev/c. The data are discussed with special reference to the role of isobar excitation in the production of secondary particles. All qualitative features of the experimental data are shown to be consistent with a dominant role of isobar decay in the production of pions, positive kaons, and pro-

tons at small angles. Excitation of isobars is shown to proceed without exchange of isospin between the colliding nucleons. Direct excitation of strange isobars can be ruled out. Evidence is presented for reduced probability of isobar production at 0°. (auth)

12222 ELECTRON HELICITY IN THE FINAL STATE OF ELASTIC e-p AND e-d SCATTERING. G. Ramachandran and R. K. Umerjee (Inst. of Mathematical Sciences, Madras). Phys. Rev., 137: B978-81(Feb. 22, 1965).

The percentage helicity of high-energy electrons scattered by target polarized protons and deuterons is discussed assuming one-photon exchange. With target protons polarized parallel to the direction of the incident beam, the back-scattered electrons get 100% polarized, which is expected to be of considerable experimental interest as a method of producing polarized electrons. Taking into account all possible types of deuteron target polarization, it is found that the percentage helicity of the final electrons is nonzero only if the targets are linearly polarized, and the relevance of this process to the study of the electromagnetic form factors of the neutron is also discussed. (auth)

12223 FOUR-PION MODELS FOR ETA AND X^0 MESONS. A. N. Mitra and Shubha Ray (Univ. of Delhi). Phys. Rev., 137: B982-92(Feb. 22, 1965).

A four-pion formalism is set up through a semirelativistic Schrödinger equation with pairwise $\pi-\pi$ interactions in the p state. Two kinds of interaction with factorable kernels, both of which reproduce the mass and width of the ρ meson, are considered: (a) an intrinsically attractive interaction which has a very short range and (b) a long-range interaction which is repulsive at low energies but becomes attractive at high enough energies. The four-pion states of T = 0 are analyzed in terms of spatial and isospin functions of appropriate symmetries, and these are used to examine the spin-parity states of 0^{-+} and 1^{++}, which are the only 4π states of T = 0 depending on $\pi-\pi$ interaction in odd-l states, via Bose statistics. By the assumption of factorable kernels, these equations are exactly reducible to equivalent three-body equations. The solutions of these equations, which can be obtained under certain reasonable approximations show that the results are incompatible with a bound pseudoscalar state of T = 0, so that the η meson cannot be understood on this model. The model also rules out an axial-vector state of T = 0, bound or resonant. However, the model predicts a resonant-pseudoscalar state at a mass very close to that of X^0 (960 Mev), and a second one at about 1.4 Bev, only when the $\pi-\pi$ interaction is of type b, but not if it is of type a. Certain other implications of a type b interaction are discussed briefly. (auth)

12224 THRESHOLD BEHAVIOR OF REGGE TRAJECTORIES. A. E. A. Warburton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Rev., 137: B993(Feb. 22, 1965).

It is pointed out, with simple examples, that the expected threshold behavior of Regge trajectories need be of no practical significance. The term giving the leading order behavior at low energies may be small compared with other terms, for energies at which the phase shifts are still of order 10^{-6}. (auth)

12225 RECIPROCAL BOOTSTRAP MODEL FOR THE RHO AND B MESONS. Jerrold Franklin (Univ. of California, Livermore). Phys. Rev., 137: B994-6(Feb. 22, 1965).

A reciprocal bootstrap mechanism is shown to exist between the ρ meson and a 2^- $\pi-\omega$ resonance (B meson). The static model is used and the same self-consistency is established as exists in the reciprocal bootstrap relation of the N and N^* in the $\pi-$ N system. The exchange of the ρ causes the force responsible for the B meson and the exchange of the B results in a stronger force which binds the ρ. The result then implies that the ρ meson is basically a $\pi-\omega$ bound state which is unstable with respect to decay into two pions. (auth)

12226 LEHMANN-SYMANZIK-ZIMMERMANN FORMALISM IN THE LEE MODEL. M. Stephen Maxon and Richard B. Curtis (Indiana Univ., Bloomington). Phys. Rev., 137: B996-1001(Feb. 22, 1965). (UCRL-12046)

The Lehmann-Symanzik-Zimmermann (LSZ) asymptotic condition on the V, N, and θ fields is shown to be equivalent to the usual prescription for constructing scattering states as solutions of the eigenvalue equation. The reduction formula relating the scattering amplitudes to the τ functions is given. Then the coupled equations for the τ functions appropriate to the $V-N\theta$ sector are written down and solved algebraically by transforming to momentum space. This approach is compared with the straightforward solution of the eigenvalue problem and the dispersion treatment found in the literature. It is concluded that LSZ formalism elucidates the basic structure of the model in the most natural way, giving rise to considerable mathematical simplification. (auth)

12227 RENORMALIZATION EFFECTS OF LEPTONIC DECAY COUPLING CONSTANTS IN BROKEN SU_3 SYMMETRY. Ken Kawarabayashi and Walter W. Wada (International Center for Theoretical Physics, Trieste, Italy). Phys. Rev., 137: B1002-8(Feb. 22, 1965).

By analyzing the tensor $T^{\mu 3}_{\beta 3}$ in U_3, the theorem of Ademollo and Gatto on the nonrenormalization of the vector leptonic decay coupling constants to first order in symmetry breaking is reproduced. To second order, by analyzing $T^{\mu 3}_{\beta 3}$, it is found that there exists one sum rule among the strangeness-changing vector coupling constants. For the axial vector coupling constants there are in general two sum rules to first order in symmetry breaking. In the $\varphi-\omega$ mixing model one obtains an additional sum rule. With regard to the equal-time commutation relations of weak currents in broken SU_3, a theorem is obtained that the one-particle approximation always leads to results which are consistent only with exact symmetry. A qualitative discussion of the relation between the two results is given. (auth)

12228 AN OPTICAL MODEL FOR HIGH-ENERGY SCATTERING. A. Baiqui (Univ. of Chicago). Phys. Rev., 137: B1009-21(Feb. 22, 1965).

An attempt is made to show that the behavior of the diffraction width in high-energy scattering can be attributed to the presence of the inelastic threshold in one of the channels that dominates the process. The theory which orginally concerns itself with p-p diffraction scattering is a pure optical model. It starts with the assumption that high-energy scattering is dominated by inelastic processes and that the degree of inelasticity is determined by the overlap of the meson clouds surrounding the colliding particles. Three input parameters are introduced into the framework, viz. the inverse range of the nucleonic meson cloud μ, the power λ in the ansatz used to relate the overlap function with the transparency coefficient, and the cut-off mass μ_1 which originates in the requirement that there be a minimal energy of local excitation in order that an inelastic process can take place. In this optical model one can identify λ with the strength of the absorptive potential. These parameters can be fixed by using the experimental data as follows: The limits (σ_{el}/σ_T) and σ_T at infinite energy give the values of λ and μ, respectively, while μ_1 is determined from approach $\sigma_T(E) \to \sigma_T(\infty)$ in the asymptotic region. With the appropriate values of the parameters one can predict the transient shrinkage of the diffraction width p-p and K^+-p scattering and also the transient expansion of the diffraction width in $\bar{p}$-p and K^--p scattering. One can also show that the widths of the diffraction peak in π^+-p and π^--p scattering are almost energy-independent. The consequences of the application of the model on non-diffractive processes are the following: In large angle scattering the differential cross section tends to flatten with increasing momentum transfer. At relativistic energies the one-fourth-power law for the average multiplicity of the secondaries in Fermi's statistical theory is quenched by a logarithmic factor. (auth)

12229 CONSISTENCY CONDITIONS ON THE STRONG INTERACTIONS IMPLIED BY A PARTIALLY CONSERVED AXIAL-VECTOR CURRENT. Stephen L. Adler (Princeton

Univ., N. J. and Bell Telephone Labs., Murray Hill, N. J.) Phys. Rev., 137: B1022-33(Feb. 22, 1965).

It is shown that a partially conserved $\Delta S = 0$ axial-vector current ($\partial_\lambda J_\lambda^A = C\varphi_\pi$) implies consistency conditions involving the strong interactions alone. The most interesting of these is a relation among the symmetric isotopic-spin pion-nucleon scattering amplitude $A^{\pi N(+)}$, the pionic form factor of the nucleon $K^{NN\pi}$, and the rationalized, renormalized pion-nucleon coupling constant g_r: $g_r^2/M = A^{(+)}(\nu = 0, \nu_B = 0, k^2 = 0)/K^{NN\pi}(k^2 = 0)$. [M is the nucleon mass and $-k^2$ the (mass)^2 of the initial pion. The final pion is on mass shell; the energy and momentum transfer variables ν and ν_B are defined.] By using experimental pion-nucleon scattering data, it is found that this relation is satisfied to within 10%. Consistency conditions involving the $\pi\pi$ and the $\pi\Lambda$ scattering amplitudes are stated. (auth)

12230 SOLUTIONS TO APPROXIMATE INTEGRAL EQUATIONS FOR REGGE POLE PARAMETERS. D. Hankins, P. Kaus, and C. J. Pearson (Univ. of California, Riverside). Phys. Rev., 137: B1034-9(Feb. 22, 1965).

A method described in a previous paper is tested in the light of potential theory. The method is based on dispersion relations for Regge pole parameters. The approximations consist in coupling the β's to the α's by applying unitarity at $l = \alpha$ and considering only a few poles. When the generalized potential is replaced by a nonrelativistic potential, the coupling equations and solutions to the integral equations can be compared to exact results. Various representations are tested, and it is found that the modified Khuri representations for A(l,s) gives good results for $\alpha_1(s)$ in the one-trajectory approximation for Yukawa potentials strong enough to cause bound S states. The results for $\beta_1(s)$ are less satisfactory. The effect of coupling in the second trajectory is considered. (auth)

12231 NEW RESONANCES AND THE VECTOR-MESON SYSTEM. D. Flamm (Univ. of Chicago). Phys. Rev., 137: B1039-43(Feb. 22, 1965).

Under the assumption of exact SU_3 symmetry the force between two degenerate vector-meson octets due to the exchange of a vector, pseudoscalar, and scalar octet is investigated. It is found that many of the recently discovered particles may fit into this scheme as bound states. However, the model does not reproduce the well-known pseudoscalar and vector-meson octets which are its input, but suggests a second octet of each kind at higher mass. It also gives a 0^+ and 2^+ singlet and octet as well as 1^+ and a 2^- octet. (auth)

12232 EXACT SOLUTION TO A BOOTSTRAP PROBLEM. H. Lee Watson (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: B1053-63(Feb. 22, 1965).

An exact bootstrap solution is found for a model of $K\overline{K}$ scattering in which only the S-wave amplitudes are kept in both the direct and crossed channels. The model, of course, is approximate and does not satisfy crossing exactly. An exact solution to this model is obtained, and an iteration method which should be applicable to more physical models is described. Neither charge independence nor charge symmetry is assumed; thus, there are four independent amplitudes to be calculated. The resulting solution is charge-independent and has two independent amplitudes, corresponding to I = 0 and I = 1. A search is made for other solutions, but none are found. (auth)

12233 POSSIBLE EXPLANATION FOR THE EXPONENTIAL DAMPING OF LARGE TRANSVERSE MOMENTA OF PARTICLES PRODUCED IN HIGH-ENERGY COLLISIONS. P. Dennery and A. Krzywicki (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev., 137: B1064-70(Feb. 22, 1965).

It is suggested that the existence of vector bosons coupled to conserved currents and the independence of emission of secondaries in multiple production processes may together explain the observed exponential shape of the transverse-momentum distributions of particles produced in high-energy collisions. (auth)

12234 DISPERSION THEORY MODEL OF THREE-BODY PRODUCTION AND DECAY PROCESSES. I. J. R. Aitchison (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev., 137: B1070-84(Feb. 22, 1965).

Three-body production and decay processes, A + B → a + b + c and A → a + b + c are investigated. It is assumed that the amplitudes are determined in both cases solely by the final-state interactions among pairs of a, b, and c, and that the dynamics are given by single-variable dispersion terms in each two-body channel (that is, a representation of the Khuri-Treiman type). Applying a method introduced by Anisovich, a linear integral equation is obtained, which gives the three-body amplitude in terms of the two-body one g. In an effective-range approximation for g, the kernel can be easily evaluated; it is the sum of the discontinuities of the triangle graph in perturbation theory, when considered as a function of an internal mass. In the S-wave case, the resulting integral equation has a unique solution depending on one arbitrary parameter (a subtraction constant). In the nonrelativistic limit, the equation coincides with Anisovich's; this in turn is analogous to the equation derived by Skornyakov and Ter-Martyrosyan for a three-body problem in potential theory, with delta-function forces. It is suggested that the theory is therefore a relativistic analog of a potential model with short-range forces. As applications, the determination of the final-state pion spectra in $K \to 3\pi$ decay, and the possibility of studying the generation of resonance in the total center-of-mass energy, induced by iterations of real particle exchange processes (the Peierls mechanism), are considered. (auth)

12235 DETERMINATION OF SIGMA-LAMBDA RELATIVE PARITY. Cynthia Alff, N. Gelfand, U. Nauenberg, et al. (Columbia Univ., New York). Phys. Rev., 137: B1105-14(Feb. 22, 1965).

An experiment was performed to determine the Σ-Λ relative parity, through a study of the decay mode $\Sigma^0 \to \Lambda^0 + e^+ + e^-$. The Σ^0 were produced by stopping K^- mesons in the 30-in. hydrogen chamber, in the reaction $K^- + p \to \Sigma^0 + \pi^0$, and 314 events were identified. The experimental distribution of the combined mass of the electron-positron pair was compared to that predicted by Feinberg, by Feldman and Fulton, and by Evans. If it is assumed that the dependence of the form factors on the combined mass of the electron-positron pair can be neglected, and that the ratio of the electric form factor F_1 to the magnetic form factor F_2 is less than 6, then the data show that the Σ-Λ relative parity is even. (auth)

12236 PI-p ELASTIC SCATTERING IN THE ENERGY RANGE 300-700 Mev. Philip M. Ogden, Donald E. Hagge, Jerome A. Helland, Marcel Banner, Jean-Francois Detoeuf, and Jacques Teiger (Univ. of California, Berkeley). Phys. Rev., 137: B1115-25(Feb. 22, 1965). (UCRL-11180 (Rev.))

Differential cross sections for elastic π-p scattering were measured at eight energies for positive pions and seven energies for negative pions. Energies ranged from 310 to 650 Mev. These measurements were made at the 3-Bev proton synchrotron. A beam of pions from an internal BeO target was directed into a liquid-hydrogen target. Fifty-one scintillation counters and a matrix-coincidence system were used to measure simultaneously elastic events at 21 angles and charged inelastic events at 78 π-p angle pairs. Events were detected by coincidence of pulses indicating the presence of an incident pion, scattered pion, and recoil proton, and the results were stored in the memory of a pulse-height analyzer. Various corrections were applied to the data and a least-squares fit was made to the results at each energy. The form of the fitting function was a power series in the cosine of the center-of-mass angle of the scattered pion. Integration under the fitted curves gave values for the total elastic cross sections (without charge exchange). The importance of certain angular-momentum states is discussed. The π^--p data are consistent with a D_{13} resonant state at 600 Mev, but do not necessarily require such a resonant state. (auth)

12237 THE DIRAC DENSITY MATRIX. K. J. Le Couteur (Australian National Univ., Canberra). Proc. Phys. Soc. (London), 84: 837-43(Dec. 1964).

An explicit expression is given for the Dirac single-particle density matrix in terms of the particle density and its derivatives. For Thomas-Fermi type calculations a reduction by a factor $\frac{1}{9}$ in the coefficient of the Weizsacker inhomogeneity correction to the kinetic energy is implied. (auth)

12238 SIMPLE LIE ALGEBRAS OF RANK 3 AND SYMMETRIES OF ELEMENTARY PARTICLES IN THE STRONG INTERACTION. Michiji Konuma, Kazuhisa Shima, and Morihiro Wada (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., No. 28, 1-131(1963).

The representation theory of Lie groups and its applications in the symmetries of elementary particles are discussed. An attempt is made to examine the framework of various Lie groups, to elucidate what parts of the representation theory are essential to the analysis of the symmetries, and to investigate what Lie group is appropriate for the analysis. (C.E.S.)

12239 SYMMETRY GROUPS IN PHYSICS. Kirk W. McVoy (Univ. of Wisconsin, Madison). Rev. Mod. Phys., 37: 84-105(Jan. 1965).

The part of group representation theory employed in the spectroscopic classification of energy levels is summarized. A summary of the general properties of semisimple Lie groups, sufficient to make the treatment self-contained, is included. Attention is then focused on Racah's important invariant operators (such as $J^2 = J_1^2 + J_2^2 + J_3^2$ for the rotation group), whose eigenvalues provide the essential connection between group theory and physics by serving as the good quantum numbers which label the multiplets and energy levels of the system. The rotation and isospin groups are used as examples throughout the discussion. The way in which, in entirely analogous fashion, SU_3 and larger groups are being employed at present in the classification of strong-interaction multiplets is described. (auth)

12240 DERIVATION OF NONRELATIVISTIC HAMILTONIAN FOR ELECTRONS FROM QUANTUM ELECTRODYNAMICS. Takashi Itoh (Tokyo Univ.). Rev. Mod. Phys., 37: 159-65(Jan. 1965).

The effective quantum-mechanical hamiltonian for a system of electrons in a static electromagnetic field is derived from quantum electrodynamics for electron velocities small compared with the velocity of light. The hamiltonian obtained is almost identical with the one obtained by Bethe and Salpeter, but there is a small difference, of which an explanation is given. (auth)

12241 POSSIBLE POLARIZATION EXPERIMENTS IN FERMION-FERMION SCATTERING AS A TEST OF INVARIANCE PRINCIPLES. Paul L. Csonka (Johns Hopkins Univ., Baltimore, Md.). Rev. Mod. Phys., 37: 177-200(Jan. 1965).

"Fermion" is taken to mean "spin-$\frac{1}{2}$ fermion." Discussion is restricted to processes in which two arbitrary incoming fermions are scattered into two arbitrary fermions (not necessarily the same) in the final state. Invariance under space inversion (P_5), time reversal (P_T), and charge conjugation (P_C) is not assumed to hold necessarily. Formulas are derived which can be applied to any polarization experiment, including correlation experiments. Necessary conditions are obtained which can be tested experimentally to check whether a certain invariance principle holds in nature. In addition to P_5, P_T, P_C invariance and their combinations, certain helicity invariance principles (related to γ^5 invariance principles) are discussed. The treatment is relativistic. By a suitable choice of rest frames for each particle, the appearance of some trigonometric functions of the scattering angle is avoided, and σ matrices can be used instead of γ matrices. Experiments in which the two incoming fermions are uncorrelated and one of them is unpolarized are treated in great detail. It is shown to what extent such experiments can determine the S matrix. A graphical method is introduced which can often be used to simplify discussion of multiple scattering experiments. Fermion-spin-zero-boson scattering is treated as a special case of fermion-fermion scattering. Those consequences of invariance principles which can be checked most easily in general polarization experiments are discussed. (auth)

12242 ELEMENTARY PARTICLES IN A CURVED SPACE. C. Fronsdal (Univ. of California, Los Angeles). Rev. Mod. Phys., 37: 221-4(Jan. 1965).

A report is given on the beginning of a project to determine the consequences of the assumption that a physical theory in flat space is obtainable as the limit of a physical theory in a curved space. Because of the absence of groups of motion in general curved spaces, only the case of constant curvature is discussed. Then operators of angular and linear momentum exist, and it is shown that the interesting irreducible unitary representations of the group of motions reduce very simply to those of the inhomogeneous Lorentz group in the limit of zero curvature. (auth)

12243 EMBEDDED SPACE-TIME AND PARTICLE SYMMETRIES. Yuval Ne'eman (California Inst. of Tech., Pasadena). Rev. Mod. Phys., 37: 227-30(Jan. 1965).

The bootstrap yields the strong-interactions symmetry provided the hadron currents participating in nonstrong interactions are first fed into it; the alternative course, in which the bootstrap is required to generate the entire symmetry uniquely, with no a priori information from the nonstrong interactions, seems to lie beyond the present techniques and would also leave unexplained the subsequent emergence of the weaker couplings. It is suggested that internal symmetries may have a geometrical origin, corresponding to transformations in the global embedding space of the four-dimensional physical Riemann universe. These would be the unitary or orthogonal tranformations of the normal subspace, since the latter do transform a small region of curved space--time into itself. This picture fits in with the short ranges of the strong interactions. Cosmological and astrophysical implications are noted. (auth)

12244 EFFECTS OF SYNCHROTRON EMISSIONS ON ORIENTED SPIN OF ELECTRONS. I. M. Ternov, V. G. Bagrov, and R. A. Rzaev. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 4, 62-70(July-Aug. 1964). (In Russian)

The effects of synchrotron emission from fast moving electrons in a constant and homogeneous magnetic field on longitudinal and transverse electron spin polarization were investigated. It is shown that as a result of radiation the initially nonpolarized electrons acquire a preferred spin orientation in an opposite direction to the external field intensity vector. (tr-auth)

12245 NONLEPTONIC DECAYS OF HYPERONS AND UNITARY SYMMETRY. Xing-chang Song. Wu Li Hsueh Pao, 20: 1048-52(Oct. 1964). (In Chinese)

The nonleptonic decay processes, $\Xi^- \to \Lambda\pi^-$, $\Lambda \to p\pi^-$, $\Sigma^+ \to p\pi^0$, $\Sigma^+ \to n\pi^+$, and $\Sigma^- \to n\pi^-$, are examined using SU_3 symmetry. The spurion $S = \begin{pmatrix} 000 \\ 001 \\ 000 \end{pmatrix}$ is introduced, writing the hamiltonian in the following form: $H_w = \sum_{i=1}^{9} C_i A_i + hc.$ It was further assumed that H_w is constant and for the nonleptonic weak interaction $A \to B\pi$ the following relation was derived: $H_{A\to B\pi} = (g_v/\sqrt{6})\bar{B}O_\mu A\partial_\mu \pi$. The theoretical results indicate that the asymmetry parameters agree well with the experimental values. Therefore, the RC nonconvertibility is valid also for nonleptonic weak interactions. The unitary symmetry conditions are also satisfied. It is of interest to note that both weak or strong interactions involve the same high level of symmetry. (TTT)

12246 ISOTOPIC SPIN CHANGES IN K-MESON DECAYS. Hong Guan. Wu Li Hsueh Pao, 20: 1053-5(Oct. 1964). (In Chinese)

In the weak interaction model of T. D. Lee (Phys. Rev. Letters 9: 319(1962)) it is assumed that the following selection rules for $KW\pi$ are satisfied: $\Delta I = \frac{1}{2}$ and $|\Delta I| = 0$.

Therefore in the decay process $K \rightarrow 2\pi$ the condition $|\Delta I| = 1/2$ will prevail. Lee also predicted that: $\Gamma(K^+ \rightarrow \pi^0 e^+ \gamma)/\Gamma(K_2^0 \rightarrow \pi^\pm e^\mp \gamma) = 1/2$. However, the experimental value obtained is 0.89 ± 0.30, thus deviating from the theoretical prediction. This difficulty may be solved if a component $|\Delta I| \neq 1/2$ exists. On the basis of this assumption the effect of the component $|\Delta I| = 3/2$ of the $\pi e \nu$ decay in the 2π decay process was examined. The experimental value of 0.89 was confirmed by the calculation. (TTT)

12247 INELASTIC AMPLITUDES IN THE LEE MODEL POSSESSING CROSSING SYMMETRIES. T. S. Chang. Wu Li Hsueh Pao, 20: 1090-1100(Nov. 1964). (In Chinese)

The first inelastic amplitudes in the Lee model possessing crossing symmetries are shown to satisfy a pair of simultaneous integral equations of Omne's type which may be solved in the usual way, on assuming known elastic amplitudes. The equations may be written in such a way that the inhomogeneous terms are small in the elastic region of one of the variables. From this, it is shown that it is possible that the inelastic contributions to the absorptive part of the elastic scattering are small in the first inelastic region. A set of integral equations displaying fuller crossing symmetry among the θ particles involved is proposed. (auth)

12248 THE LIFETIME OF THE MUON AND THE EXPERIMENTAL LIMITATION OF THE μ-e SYMMETRY. Leau-fu Lo (Inner Mongolian Univ., [China]), Tan Lu, and Kuo-shen Yang. Wu Li Hsueh Pao, 20: 1101-13(Nov. 1964). (In Chinese)

The μ-e symmetry is destroyed by the anomalous interaction. The influence of the anomalous interaction on the weak-processes is discussed, and the relation between the renormalization of the weak-interaction constant and such properties of the anomalous interaction as the charge independence and the γ_5-transformation are analyzed. The renormalized constants are shown to be $G_V = G$, $G_A = \epsilon G$, $\epsilon = 1 + \delta$. This result is used to solve the difficulty which occurs when one uses the universal V-A Fermi weak-interaction theory and the conserved vector current hypothesis to explain the lifetime of the muon. Comparing the theory with various experiments, the result $\delta = 0.04$ is found, which may be interpreted as the experimental limitation of the μ-e symmetry. (auth)

12249 K-$\bar{K}$ RESONANCE. Pei-wei Hsu, Fan-mei Kung, and Hsuch-hui Kung (Nankai Univ., [China]). Wu Li Hsueh Pao, 20: 1129-34(Nov. 1964). (In Chinese)

The existence of a resonance in K-$\bar{K}$ pair with a mass of 1.02 Bev was recently observed in π^+-p and K^--p collisions. In several reports the quantum numbers in this resonant state were determined, but the results are different from one another. From the field theoretical point of view and by means of the chain approximation, the interaction potential of the K-$\bar{K}$ system was calculated, and it is indicated that there is a resonance at 1.02 Bev with $T = 0$, $J^{PC} = 0^{++}$. (auth)

12250 INELASTIC PERIPHERAL COLLISIONS AT ULTRA-HIGH ENERGIES. P. Smrz (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1736-9(Nov. 1964). (In Russian)

The asymptotic values for inelastic peripheral collisions are calculated in the one-meson approximation. The asymptotic values of the mean inelasticity coefficient and of the transverse momentum of the recoil nucleus are calculated under the assumption that at the energies lying above the resonance region the πN interactions are completely due to exchange of a single pion. The values for the total cross sections $\sigma_{NN} = 40$ mb and $\sigma_{\pi N} = 22.5$ mb yield the the values $\bar{K} = 0.36$ and $\bar{P}_\perp = 0.47$ Bev/c. (auth)

12251 ON THE NUMBER OF DIAGRAMS FOR ONE- AND TWO-PARTICLE GREEN FUNCTIONS IN THE CASE OF DIRECT FERMION INTERACTION. A. A. Akopyan (Inst. of Semiconductors, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1742-5(Nov. 1964). (In Russian)

The number of topologically nonequivalent Feynman diagrams for one- and two-particle Green functions is computed in arbitrary order of perturbation theory by the symmetrized as well as unsymmetrized technique. (auth)

12252 A PHENOMENOLOGICAL ANALYSIS OF SCATTERING OF PHOTONS ON NUCLEONS. M. P. Rekalo (Inst. of Physics and Tech., Academy of Sciences, Ukrainian, SSR). Zh. Eksperim. i Teor. Fiz., 47: 1751-6(Nov. 1964). (In Russian)

The problem of a complete experiment of scattering of photons on nucleons is considered. Various choices of experiments required for the determination of the amplitude for scattering of photons by nucleons are analyzed. (auth)

12253 A PROPERTY OF LEPTON RADIATION EMITTED IN THE INTERACTION BETWEEN NEUTRINOS AND MATTER. G. V. Shishkin (Inst. of Heat and Mass Exchange, Academy of Sciences, Belorussian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1757-8(Nov. 1964). (In Russian)

It is shown that the polarization properties of leptons produced in the interaction between neutrinos and matter (reactions of the type $\nu + N \rightarrow N' + L$) in a certain case may not depend on the weak interaction constant.

12254 ON THE FIELD THEORY OF WEAK INTERACTIONS. O. V. Kancheli and S. G. Matinyan. Zh. Eksperim. i Teor. Fiz., 47: 1790-9(Nov. 1964). (In Russian)

Weak interaction between bosons and leptons is analyzed by the Feinberg-Pais procedure. It is shown that the contact terms in the Born term disappear from the amplitude. These terms appear, however, if form factors of strong interactions are taken into account. (auth)

12255 INELASTIC SCATTERING OF NEUTRINOS BY DEUTERONS. Yu. V. Gaponov and I. V. Tyutin. Zh. Eksperim. i Teor. Fiz., 47: 1826-8(Nov. 1964). (In Russian)

The cross-section of the $\nu + d \rightarrow \nu + p + n$ reaction for S- and P-states of the np pair is calculated. The weak interactions hamiltonian with neutral current ν were used in the calculations. (auth)

12256 POLES OF THE SINGLE-VERTEX FUNCTION AND ORTHOGONALIZATION OF ONE-PARTICLE STATES. B. V. Geshkenbein and B. L. Ioffe. Zh. Eksperim. i Teor. Fiz., 47: 1832-5(Nov. 1964). (In Russian)

It is shown that the poles of a single-vertex function which appear if there are two elementary particles a_1 and a_2 in a single channel, disappear if the wave functions of particles a_1 and a_2 are orthogonalized. (auth)

12257 REGGE POLE TRAJECTORIES FOR THE NONRELATIVISTIC TWO-CHANNEL PROBLEM. V. P. Belov and V. M. Shekhter (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 1855-67 (Nov. 1964). (In Russian)

The behavior of Regge pole trajectories is studied for the two-channel nonrelativistic problem with a Yukawa potential. At high energies two trajectories intersect at each integer negative point; this corresponds to the number of channels. The dependence of the trajectory on energy is investigated for the weak coupling case. Qualitatively it remains the same as that for the one-channel problem. With increase of the number of trajectories their collision rate also increases, that is, the number of branching points in the complex energy plane increases. All the results can easily be extended to the case of the multi-channel problem. (auth)

12258 EFFECT OF THE MEDIUM ON THE PROPERTIES OF $K^0\bar{K}^0$ MESON PAIRS. V. L. Lyuboshits, E. O. Okonov, and M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1868-73(Nov. 1964). (In Russian)

The effect of coherent interaction of K^0 and $\bar{K}^0$ mesons with the medium on the properties of $K^0\bar{K}^0$ pairs is considered. A set of basic functions for such pairs in the

medium is found and some specific features of interference in $K^0\bar{K}^0$, $K_1^0K_2^0$, $K_1^0(K_2^0)$, and $K^0(\bar{K}^0)$ systems are noted. The accuracy of the usual approximation in which K^0 mesons are regarded as free is estimated. (auth)

12259 ENERGY DEPENDENCE OF THE LIFETIME OF QUASISTATIONARY STATES. A. I. Baz. Zh. Eksperim. i Teor. Fiz., 47: 1874-6(Nov. 1964). (In Russian)

A formula is derived for the dependence of the lifetime of quasistationary states on the exact value of the energy. (auth)

12260 ANNIHILATION OF HIGH-ENERGY ANTIBARYONS. M. P. Rekalo (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1886-92(Nov. 1964). (In Russian)

Annihilation of high energy baryon-antibaryon pairs with formation of mesons and γ quanta is considered. Expressions for spiral amplitudes are obtained in two asymptotic regions; the amplitudes are employed for calculating the differential cross section and various polarization coefficients. Isotopic relations between the cross sections for various values of the reggeon isospin are derived. (auth)

12261 WEAK INTERACTIONS IN COLLIDING ELECTRON BEAMS. B. L. Ioffe, L. B. Okun, and A.P. Rudik (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1905-18(Nov. 1964). (In Russian)

Possible experiments for investigation of weak interactions in electron-electron or electron-positron beams are discussed for energies of the order of 100–1000 Bev when the weak interaction becomes strong. The main results of the investigation are presented and refer to processes which occur in the second order of perturbation theory with respect to weak interaction and are described by diagrams. (auth)

12262 THE RELATION BETWEEN POLARIZATION EFFECTS OF PROCESSES INVOLVING A SINGLE ISOBAR. M. S. Dubovikov (Inst. of Physics and Tech., Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1933-8(Nov. 1964). (In Russian)

The relation between polarization effects of the following processes proceeding via a single isobar is discussed: $\gamma + N \to V + N$, $\gamma + N \to \pi + N$, $\pi + N \to V + N$ and $\pi + N \to \pi + N$, where V is a vector meson. Decay of the vector meson into two or three pseudoscalar particles is considered. (auth)

12263 THE CAUSALITY PRINCIPLE AND ASYMPTOTIC BEHAVIOR OF THE SCATTERING AMPLITUDE. N. N. Meiman (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1966-83(Nov. 1964). (In Russian)

The elastic scattering reaction $p + k \to p' + k'$ is considered, where p and p' are the 4-momenta of particle before and after scattering respectively and k and k' are the same for another particle. Two auxiliary amplitudes $A^{ret}(s,t)$ and $A_{\infty}^{adv}(s,t)$ are introduced. The first of these functions asymptotically coincides with the reaction amplitude in the physical region of the reaction and the second asymptotically is identical with the amplitude of the cross reaction in the physical region of the latter. It is proven that A^{ret} and A_{∞}^{adv} are analytical with respect to s in the upper and lower half planes respectively and at complex infinity grow slower than any linear exponential function. The structure of permissible generalized functions can then be derived on basis of microcausality. The generalized functions may contain derivatives of δ functions of all orders and may not, as is usually considered, be generalized functions of temperate growth. The Pomeranchuk theorem on asymptotic equality of the total cross sections for particles and antiparticles and the asymptotic equality of the differential cross sections is proved without assuming analyticity of the scattering amplitude. Thus an experimental confirmation of equality of cross sections cannot be regarded as an unequivocal proof of analyticity of the amplitude. (auth)

12264 INTERACTION OF 19.8-Gev/c PROTONS WITH NUCLEONS AND EMULSION NUCLEI. E. G. Boos, N. P. Pavlova, Zh. S. Takibaev, T. Temiraliev, and R. A. Tursunov (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 47: 2041-50 (Dec. 1964). (In Russian)

Interactions between protons and nucleons and emulsion nuclei are investigated. A total of 7960 events were detected for a total primary track length of 2927 meters. This corresponds to a mean free path $\lambda = 36.8 \pm 0.4$ cm. A total of 1035 inelastic pN interactions were selected. The distribution of pp events with respect to number of rays is in accord with hydrogen bubble chamber data. The mean number of charged secondary particles from pp and pn interactions are respectively 4.3 ± 0.2 and 4.5 ± 0.2. Showers with asymmetric emission of charged particles in the cms are studied. The asymmetry distribution of individual interactions can be explained by assuming that the shower particles are deflected in a random fashion from symmetric emission. The dependence of mean plurality on the type of target nucleus is analyzed. The experimental data are compared with the predictions of various theoretical conceptions regarding the mechanism of interaction between nucleons and nuclei. It is shown that the best agreement is attained in the case of the cascade model calculations. (auth)

12265 ANALYTICAL PROPERTIES OF THE AMPLITUDE WITH RESPECT TO TRANSFERRED MOMENTUM AND THE ASYMPTOTIC BEHAVIOR OF SCATTERING PHASE SHIFTS. V. S. Popov (Inst. of Theoretical and Experimental Physics, Erevan). Zh. Eksperim. i Teor. Fiz., 47: 2229-46(Dec. 1964). (In Russian)

The relation between the closest singularity z_0 of the scattering amplitude $f(E,z)$ and the asymptotic value of the partial amplitudes $f_l(E)$ for l are considered in a general form. Two different cases are investigated: z_0 lies outside the physical region, $-1 \le z \le 1$; z_0 is at the boundary of the physical region, $z_0 = +1$. The method employed consists in changing from a Legendre polynomial series into a power series. The results obtained are applied to a nonrelativistic scattering potential. The position and character of the closest singularity of the amplitude for scattering on a potential with an asymptotic expression of the type $(\mu r)^{-\nu} \exp[-(\mu r)^{\alpha}]$, $0 \le \alpha \le +\infty$ are determined. The method developed is applied for investigating the cross sections for interaction of elementary particles at high energies. A simple derivation of the Froissart inequality which restricts the growth of the total cross section for interaction of elementary particles for $s \to \infty$ is obtained. (auth)

12266 RESONANCE SCATTERING OF PHOTONS ON PHOTONS VIA INTERMEDIATE BOUND STATES. S. Ya. Guzenko and P. I. Fomin (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 2276-8(Dec. 1964). (In Russian)

Formulas are derived for the cross section of resonance scattering of photons on photons via e^+e^- (positronium) and $\mu^+\mu^-$ bound states. The resonance cross section reaches 10^{-20} cm^2. (auth)

12267 PION AND β-RADIATION FROM PROTONS MOVING IN A MAGNETIC FIELD. V. L. Ginzburg and G. F. Zharkov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2279-84(Dec. 1964). (In Russian)

Magnetic bremsstrahlung emission of β and pion radiation by protons is discussed, that is, the transformation of a proton into a neutron in a magnetic field with emission of π mesons and β positrons is considered. It is shown that the proton energy losses due to these processes under real conditions are small compared with losses due to magnetic bremsstrahlung emission of electromagnetic waves. (auth)

12268 GROUP THEORETICAL CONCEPTS AND METHODS IN ELEMENTARY PARTICLE PHYSICS. Lectures of the Istanbul Summer School of Theoretical Physics July 16-August 4, 1962. Feza Guersey, ed. Quantum Physics and Its Applications. Volume 1. New York,

Gordon and Breach, Science Publishers, 1964. 431p.

Separate abstracts were prepared for the fourteen papers included. (D.C.W.)

For abstracts of individual papers see: 11665, 11666, 12269, 12270, 12271, 12272, 12359, 12360, 12361, 12362, 12363, 12364, 12365, and 12366.

12269 TOPICS IN HIGH-ENERGY SCATTERING THEORY. O. W. Greenberg (Univ. of Maryland, College Park). p.107-33 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

High-energy limits on total cross sections arising from the requirements of field theory and of a weak form of the Mandelstam representation are discussed, together with the relations between the high-energy cross sections for different processes. The experimental situation is outlined, as well as the theoretical arguments. (D.C.W.)

12270 THEORY OF COMPACT LIE GROUPS AND SOME APPLICATIONS TO ELEMENTARY PARTICLE PHYSICS. D. Speiser (Stanford Univ., Calif.) p.201-76 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

An introduction to the theory of compact Lie groups is presented, and some applications to elementary particle physics are considered. Global symmetries and the breaking of global symmetries by weak interactions are discussed. (D.C.W.)

12271 APPROACHES TO THE UNITARY SYMMETRY MODEL. S. L. Glashow (Harvard Univ., Cambridge, Mass.). p.277-326 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

A review of approaches to the unitary symmetry model is presented, with consideration of higher symmetry, the Sakata model, the eightfold way, mass sum rules, gauge invariance, analog symmetries, and the spontaneous breakdown of symmetries. 56 references. (D.C.W.)

12272 CHIRAL SYMMETRIES IN WEAK AND STRONG INTERACTIONS. Y. Nambu (Univ. of Chicago, Ill.). p. 327-58 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

The universal V-A theory is reviewed, and the γ_5 symmetry associated with conserved axial vector current is studied. Some models for γ_5 symmetry are summarized; and hidden symmetry is considered, together with some consequences of the γ_5 invariance of strong interactions which can be tested experimentally. Non-perturbative solutions of field equations are also discussed. (D.C.W.)

12273 LECTURES ON NEW MESONS, RESONANCES AND UNITARY SYMMETRY. J. J. Sakurai. Bombay, Tata Inst. of Fundamental Research, 1963. 128p.

The conservation laws obeyed by the strongly interacting particles are reviewed; and the quantum numbers of the baryons, mesons, and resonances are discussed with consideration of both experimental and theoretical arguments. Attempts at classification are described, particularly the unitary symmetry. The mathematical structure of the SU(3) symmetry group is considered in detail. The mass formula, ω-φ mixing, the vector current concept, and the exchange models are briefly discussed. (D.C.W.)

12274 LECTURES ON THE PROPERTIES AND THE SYMMETRY THEORIES OF THE RESONANT STATES. R. H. Dalitz. Bombay, Tata Inst. of Fundamental Research, 1962. 112p.

A survey on the properties and symmetry theories of resonant states is presented, covering both experimental and theoretical considerations. (D.C.W.)

12275 CORAL GABLES CONFERENCE ON SYMMETRY PRINCIPLES AT HIGH ENERGY, JANUARY 30-31, 1964, UNIVERSITY OF MIAMI. Behram Kursunoglu and Arnold Perlmutter, eds. A Series of Books in Physics. San Francisco, W. H. Freeman and Co., 1964. 171p. (CONF-510)

Separate abstracts were prepared for nine of the eleven papers included. The other two papers were previously abstracted for NSA (18: 14899 and 24379). (D.C.W.)

For abstracts of individual papers see: 12276, 12277, 12278, 12279, 12280, 12281, 12282, 12283, and 12357.

12276 SYMMETRY PRINCIPLES IN LEPTONIC WEAK INTERACTIONS. R. E. Marshak (Univ. of Rochester, N. Y.). p.1-19 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

The octet model of SU(3) is applied to the strangeness-conserving and strangeness-violating weak baryon currents, and the possibility of combining a baryon-lepton symmetry principle with the octet model of SU(3) for the weak baryon currents is considered. (D.C.W.)

12277 A NEW SYMMETRY GROUP FOR ELEMENTARY PARTICLES. Behram Kursunoglu (Univ. of Miami, Coral Gables, Fla.). p.20-35 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

A symmetry group, LU(4), is constructed, of which SU(3) is a subgroup and for which representations can be constructed from the representations of SU(4). The LU(4) group contains the spin degree of freedom of elementary particles as a unitary content, as well as the isotopic spin. (D.C.W.)

12278 THE HUNTING OF THE QUARK. R. K. Adair (Yale Univ., New Haven), D. A. Barge, W. T. Chu, and L. B. Leipuner. p.36-48 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

The production and properties of quarks are briefly discussed on the basis of theoretical considerations, and an attempt to detect quarks in the interactions of high-energy protons with nuclei is described. Preliminary results for 20-Bev protons on Be indicate that if quarks exist at all, it is unlikely that quarks with masses less than 2 Bev/c^2 exist with couplings to nucleons much greater than electromagnetic. (D.C.W.)

12279 DEPARTURES FROM THE EIGHTFOLD WAY. Sheldon L. Glashow (Harvard Univ., Cambridge, Mass.). p.49-57 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

Departures arising from electromagnetic, weak, and "medium-strong" interactions are discussed, with consideration of the octet currents associated with the electromagnetic and weak interactions and of the phenomena arising from the currents associated with the interactions. (D.C.W.)

12280 SU_3 SYMMETRY IN WEAK INTERACTIONS. Paul T. Matthews (Imperial Coll. of Science and Tech., London). p.70-80 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

The weak Lagrangian suggested by Cabibbo is written, assuming the existence of intermediate bossons. Tadpole dominance is then discussed, and the Cabibbo angle is briefly studied. Some applications of U-spin in weak interactions are also considered. (D.C.W.)

12281 ON DYNAMICAL SYMMETRY GROUPS AND MASS SPECTRUM OF ELEMENTARY PARTICLES. A. O. Barut (Univ. of Colorado, Boulder). p.81-92 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

An exact symmetry governing the quantum numbers and the mass states of elementary particles is considered. The construction of the symmetry group and the determination of mass and energy levels are discussed. (D.C.W.)

12282 ON THE ORIGIN OF SYMMETRIES. N. Rosen (Israel Inst. of Tech., Haifa), J. Rosen, and Y. Ne'eman. p.93-103 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

The possibility that the internal symmetries of strong

interactions emerge from space-time is discussed considering the short range of the interactions. F-spin conservation in strong interactions is obtained, the weakness of the gravitational coupling generating this symmetry. (D.C.W.)

12283 COMPARISON OF EXPERIMENTAL REACTION CROSS SECTIONS WITH VARIOUS RELATIONS OBTAINED FROM SU_3. S. Meshkov (National Bureau of Standards, Washington, D. C.). p.104-26 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

Experimental observations on the cross sections for meson-baryon interactions are compared with relations obtained from SU(3). It is concluded that the sum rule is remarkably well obeyed for both meson and vector meson production. (D.C.W.)

12284 ELEMENTARY PARTICLE PHYSICS. Gunnar Kaellen. Reading, Mass., Addison-Wesley Publishing Company, Inc., 1964. 560p. $15.00

Theory for strong interactions of strange and nonstrange particles and for weak interactions is presented, together with related experimental observations. Methods and relations for the determination of particle masses are also outlined; mass values are included. (D.C.W.)

12285 PROCEEDINGS OF THE SYMPOSIUM ON QUASI-OPTICS, NEW YORK, N. Y., JUNE 8, 9, 10, 1964. Microwave Research Institute Symposia Series. Volume XIV. Brooklyn, Polytechnic Press, 1964. Distributed by Interscience Publishers, New York, 660p. (CONF-640608)

Separate abstracts were prepared for five of the thirty-two papers included. The remaining papers deal with electromagnetic theory and devices, notably optical systems and theory. (D.C.W.)

For abstracts of individual papers see: 12286, 12287, 12703, 12704, and 12705.

12286 ČERENKOV RADIATION AND ALLIED PHENOMENA. Paul D. Coleman (Univ. of Illinois, Urbana). p.199-215 of "Proceedings of the Symposium on Quasi-Optics." Brooklyn, Polytechnic Press, 1964. (CONF-640608-10)

The similarity between the Cherenkov effect and the traveling-wave interaction is shown, and the interaction of a pre-bunched electron beam and an anisotropic plasma is considered. Various configurations of a cylindrical plasma clad with different scalar dielectrics are studied, and some preliminary experimental data on an x-band Cherenkov plasma couples driven by an s-band Rebatron beam are presented. The characteristics of various plasma guides and resonators that might advantageously be driven with a pre-bunched beam are also included. The electron beam tunnel problem, when using a plasma medium to generate high frequencies, is compared with that for other structures. (D.C.W.)

12287 A SELF-CONSISTENT THEORY OF ČERENKOV AND SMITH-PURCELL RADIATION. Istvan Palocz (International Business Machines Corp., Yorktown Heights, N. Y.) and Arthur A. Oliner. p.217-33 of "Proceedings of the Symposium on Quasi-Optics." Brooklyn, Polytechnic Press, 1964.

A self-consistent approach for the analysis of Čerenkov and Smith-Purcell radiation from modulated electron beams is presented, in which the effect of the radiation back on the beam is taken into account. The beam and the associated structures (dielectric media or periodic gratings) are treated as a unit in an eigenvalue solution, so that the requirement of self-consistency is automatically satisfied. In addition, the solution includes the effects of space charge waves on the beam. Rigorous solutions are obtained for two cases: the Čerenkov radiation for a small-signal modulated sheet electron beam of finite thickness passing between two semi-infinite dielectric regions, and the Smith-Purcell radiation for a beam similar to that above, passing between two parallel planar strip transmission gratings. For the latter case, it was necessary first to calculate the equivalent network for a wave incident on such a grating under multimode conditions. Using a simple, but accurate, perturbation procedure, numerical results were obtained for various situations. The eigenvalue approach indicates new effects for both the Čerenkov and the Smith-Purcell radiation. It is shown that the eigen-wavenumbers are complex for both phenomena, and that the radiation consists of an infinite set of fast and slow waves. The radiation does not emerge at a single angle only, even in the ideal monoenergetic case. The angular spread is usually less than 1°; however, neither experimentalists nor theorists have heretofore noted the fine structure of the radiation. The different behaviors of the fast and slow waves are examined, and the slow waves are demonstrated to be growing waves. Among other results, it is shown that an optimum beam thickness exists. (auth)

12288 ELEMENTARY PARTICLE PHYSICS AND FIELD THEORY. VOLUME 1. T. Fulton, G. Kaellen, J. D. Jackson, and C. Fronsdal. Brandeis Summer Institute 1962. Brandeis University Summer Institute Lectures in Theoretical Physics. New York, W. A. Benjamin, Inc., 1963. 537p. $11.00 (cloth edition); $5.95 (paperback).

Separate abstracts were prepared for the four sections of the book. (D.C.W.)

For abstracts of individual sections see: 12289, 12290, 12291, and 12356.

12289 RESONANCES IN STRONG INTERACTION PHYSICS. Thomas Fulton (Johns Hopkins Univ., Baltimore). p.1-122 of "Elementary Particle Physics and Field Theory. Vol. 1." New York, W. A. Benjamin, Inc., 1963.

Resonances in strong interactions are considered in terms of S-matrix and dispersion theory. A partial-wave analysis is performed from the Dirac viewpoint of states, and approximations to dispersion relations for elastic and inelastic two-particle processes are discussed. Elements of the applied field theory associated with analyses of resonance decay are reviewed. The inverse T-matrix and density matrix formalisms are demonstrated. (D.C.W.)

12290 WEAK INTERACTIONS. J. D. Jackson (Univ. of Illinois, Urbana). p.263-425 of "Elementary Particle Physics and Field Theory. Vol. 1." New York, W. A. Benjamin, Inc., 1963.

A survey of the theory of beta decay, meson (μ) decay and capture, meson (π) decay, and strange particle decays is presented, with consideration of the associated experimental observations. 280 references. (D.C.W.)

12291 GROUP THEORY AND APPLICATIONS TO PARTICLE PHYSICS. Christian Fronsdal (Univ. of California, Los Angeles). p.427-532 of "Elementary Particle Physics and Field Theory. Vol. 1." New York, W. A. Benjamin, Inc., 1963.

The theory of classical Lie groups is reviewed, including structure of continuous groups and simple Lie algebras, three-dimensional rotations, representations of simple Lie algebras, and characters and girdles. Applications to the classification of elementary particles are considered. (D.C.W.)

12292 QUASI-POTENTIAL METHOD FOR THE PROBLEM OF TWO-PARTICLE BOUND STATE. R. N. Faustov. p.108-16 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom II." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

The problem of positronium energy levels (the bound electron-positron state) was analyzed. The problem was confined to spallation magnitudes of ortho- and parapositronium ground energy levels $\Delta W = [E(1^3S_1) - E(1^1S_0)]$ calculated with the order of accuracy up to α^5 (α is the fine structure constant). It is shown that the obtained three-dimensional wave function supplied sufficient data for de-

termining positronium energy levels by means of the quasi-potential equation. Thus, the quasi-potential equation proved simpler in comparison to the Bethe-Salpeter equation which is complex and demands four-dimensional wave functions. The quasi-potential equation may be used for calculating various energy level corrections (in the fine and hyperfine structure, Lamb shift, and in the nuclear motion) of hydrogen type atoms. (R.V.J.)

12293 DISPERSION THEORY OF A LOW-ENERGY PION-PION SCATTERING. D. V. Shirkov. p.117-59 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom II." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

The kinematics, isotopic structure, and unitarity of $\pi\pi$ scattering are analyzed. A survey is made of the Chew and Mandelstam theoretical works and of the data developed by Dubna and Novosibirsk scientist for a systematical approach to low-energy strong interactions. (tr-auth)

12294 VOPROSY FIZIKI ELEMENTARNYKH CHASTITS. Tret'ya Sessiyz Vesennei Shkoly Teoreticheskoi i Eksperimental 'noi Fiziki Nor-Amberd, 3-13 Aprelya 1963 g. (Problems in Physics of Elementary Particles. The Third Session of the Spring Seminar on Theoretical and Experimental Physics, Nor-Amberd, April 3-13, 1963). Erevan, Publishing House of Academy of Sciences, 1963. 600p.

Thirty-nine papers are included. Separate abstracts were prepared for 37. Two papers were previously abstracted in NSA. (M.J.T.)

For abstracts of individual papers see: 11591, 11592, 11593, 11594, 12018, 12019, 12295, 12296, 12297, 12298, 12299, 12300, 12301, 12302, 12303, 12304, 12305, 12306, 12307, 12308, 12309, 12310, 12311, 12312, 12313, 12314, 12315, 12316, 12317, 12318, 12319, 12320, 12321, 12322, 12323, 12626, and 12702.

12295 OPENING ADDRESS. A. I. Alikhanyan. [Problems in Physics of Elementary Particles. The Third Session of the Spring Seminar on Theoretical and Experimental Physics, Nor-Amberd, Apr. 3-13, 1963.] p.5-8 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The program of the spring physics seminar at Nor-Amberd is reviewed. Strong interactions were the principal topic. The latest data concerning the concept of Regge poles are both impressive and disappointing. The experimental data of Lindenbaum and Yuon confirm the energy dependence of $(1/\sigma)(d\sigma/d\Omega)$ in the case of pp scattering but not in the case of πp scattering. A series of lectures on this topic, directed especially to experimentalists is given. Considerable time is devoted to experimental methods and particularly to spark chambers developed in the Soviet Union; in these chambers the streamer develops along the true path of the particle. The following seminar topics are mentioned: generation of beams of hard gamma rays by means of powerful laser beams, nonlinear focusing of charged particles, computer analysis of photographs from bubble chambers. A shorter part of the seminar is devoted to weak interactions. The selection rules in decay of strange particles are examined, and the meaning of the Brookhaven experiment in regard to the prediction of two neutrinos is discussed. For the first time the seminar series includes a lecture on the general properties of nuclear material. The first lecture deals with nucleon form factors and the latest experiments that have made possible the definition of the internal structure of fundamental particles. (TTT)

12296 ON THE DETERMINATION OF CROSS SECTION OF THE PION-PION INTERACTION. G. A. Leksin. p.11-29 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The cross section for pion-pion interactions $p(\pi^-, \pi^-\pi^0)p$, $p(\pi^-, \pi^-\pi^+)n$, $p(\pi^+, 2\pi^+)n$, and $p(\pi^+, \pi^+\pi^0)p$ may be inferred from pion-nucleon cross sections by the method of Chew and Low, which assumes that the incident pion interacts with only one of the virtual mesons in the shell of the nucleon. Four criteria were proposed for determining the applicability of the method of Chew and Low: 1) the differential cross section should be proportional to $q^2/(q^2+1)^2$, where q is the momentum of the scattered nucleon in units of $m_\pi c$; 2) there should be no dependence of the number of reactions upon the angle between the planes determined by the initial and final paths of the struck nucleon and by those of the incident and emitted pions (criterion of Treiman and Yang); 3) the cross section must be independent of the momentum of the incident meson; and 4) the interactions must be isotopically invariant. Comparisons with previously published experimental data show that criterion 1 is applicable only for $q^2 < 2$. The criterion of Treiman and Yang is insensitive, since at such energy levels, the scattering is mainly isotropic S-scattering. There are insufficient data to evaluate the third criterion. The fourth criterion is not observed, since the cross section for $\pi^+\pi^0$ scattering is almost 4 times that for $\pi^-\pi^0$ scattering. (TTT)

12297 BARYON ISOBARS. I. V. Chuvilo. p.30-63 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Previously published data on the quantum numbers of several isobars are discussed. The first two isobars are the N_0 with a rest mass of 938 Mev (proton or neutron), and $N_1(1238 \pm 2$ Mev), which arises in the $\pi^\mp$p system. These isobars have isotopic spins of $I = \frac{1}{2}, \frac{3}{2}$; positive parity; and angular momentum quantum numbers $l = 0, 1$. Quantum numbers for the next three can be assigned from recent data: for $N_2(1512 \pm 2$ Mev), $I = \frac{1}{2}$, $l = 2$, $j = \frac{3}{2}$, and parity is negative with respect to the π^-p system. This isobar could be a mixture of states with $I = \frac{1}{2}$ and $\frac{3}{2}$. For N_3 $(1650 \pm 25$ Mev), $I = \frac{3}{2}$, $l = 2$, $j = \frac{5}{2}$, and parity is negative. For $N_4(1688 \pm 3$ Mev), $I = \frac{1}{2}$, $l = 3$, $j = \frac{5}{2}$, and parity is positive. For the next 3 isobars, only the mass and isotopic spin can be assigned, although l and j can be inferred from extrapolation: for $N_5(1920 \pm 15$ Mev), $I = \frac{3}{2}$, $l = 3$, $j = \frac{7}{2}$; for $N_6(2190 \pm 15$ Mev), $I = \frac{1}{2}$, $l = 3$, $j = \frac{7}{2}$; for $N_7(2360 \pm 25$ Mev), $I = \frac{3}{2}$, $l = 4$, and $j = \frac{9}{2}$. For the above isobars the strangeness $S = 0$. Data for other isobars are also presented: $Y_1^*(1385$ Mev) with $S = -1$, $I = 1$, $j = \frac{3}{2}$, $l = 1$, and positive parity in $\pi\Lambda_0$ system; $Y_0^*(1520$ Mev) with $S = -1$, $I = 0$, $l = 2$, $j = \frac{3}{2}$, and positive parity in KN system; Y_0^* $(1405 \pm 50$ Mev) with $I = 1$, $S = -1$, $j = \frac{1}{2}$, and negative parity in KNY_0^* system; $Y_0^*(1815 \pm 120$ Mev) with $S = -1$, $I = 0$, $j = \frac{5}{2}$, and negative parity in KNY_0^* system. There is some evidence for $Y_0^*(1685$ Mev) with $S = -2$, $I = 1$. There is also a Ξ^* particle (1530 Mev) with $S = -2$, $I = \frac{1}{2}$. There is evidence for isobars with masses greater than 2100 Mev. (TTT)

12298 K* MESON. I. V. Chuvilo. p.64-76 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Twelve papers presented at the International Conference of High Energy Physics, 1962, concerning the K* meson are reviewed. From these papers it is concluded that the mass of the K* meson is 890 Mev with a mass-distribution width of 50 Mev. The isotopic spin $I = \frac{1}{2}$, the spin $j = 1$, and the parity is negative in the $K^*N\Lambda^0$ system. (TTT)

12299 ELECTROMAGNETIC DECAYS OF η^0 — PARTICLES. M. I. Podgoretskii. p.77-88 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Because the η^0 meson is formed by strong reactions, it is natural to assume that the two modes of decay (to neutral particles and to $\pi^+ + \pi^- + \pi^0$) are also by strong reactions. It is shown that such transitions are either forbidden or fail to explain the fact that the probability of neutral-particle decay is experimentally three times larger than decay to $\pi^+ + \pi^- + \pi^0$. Second-order electromagnetic decay, however, allows decay by $\eta^0 \to 3\pi^0$ and $\eta^0 \to \gamma + \gamma$. Then the most probable values of the η^0 quantum numbers are $I = 0$, $G = +1$, and the spatial parity is negative. Decay to π^+, π^-, and a gamma ray is also possible. However then decay to neutral particles is calculated to be much more likely than observed

in experiment. Thus it is concluded that first-order electromagnetic decay might also occur. Knowledge of the lifetime of the η^0 particle would be useful in determining the type of decay more exactly. (TTT)

12300 PION RESONANCES. S. Ya. Nikitin. p.89-102 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Resonances in the π-meson system excluding η mesons are discussed, based on experimental data published in 1962 and 1963. The M-matrix elements for the 3π decay of the resonances are presented. The ω meson has a mass of 789.9 ± 1.6 Mev and the width of less than 12.9 Mev. The quantum numbers are spin J = 1, spatial parity P = −1, charge parity G = −1, and isotopic spin I = 0. The dominant mode of decay is $\omega \rightarrow \pi^+ + \pi^- + \pi^0$, as determined by the method of insufficient masses. However about 8% of the ω mesons also decay to neutral particles. The cross section for the formation of the ω meson by the reaction $\pi^+ + p \rightarrow \pi^+ + p + \omega$ at π^+ momenta of 2.35 and 2.90 Bev/c was found to be 1.9, 1.9, and 1.2 mb. The reaction is basically a two-particle reaction $\pi^+ + p \rightarrow N^*_{33} + \omega$. The ω meson is also formed by the reactions $\pi^+ + d \rightarrow 2p + \omega$ and $p + \bar{p} \rightarrow K^+ + K^- + \omega$. For the ρ meson the mass is 730 + 10 Mev with a width of about 90 Mev. The decay schemes are $\rho^\pm \rightarrow \pi^\pm + \pi^0$ and $\rho^0 \rightarrow \pi^+ + \pi^-$. $I_\rho = 1$ and J = 1. Cross sections for $p(\pi^+,\rho^+)p$ are 2.1 and 1.4 mb at 2.34 and 2.90 Bev/c (π^+ momentum), and for $p(\pi^+,\rho^0)p\pi^+$ 1.4, 1.4, and 0.95 mb at 2.34, 2.62, and 2.90 Bev/c. Reactions $p(\bar{p},\rho^0)\pi^0$ and $p(\bar{p},\rho^\pm)\pi^{0\pm}$ were also observed. There is some preliminary experimental evidence for resonances with I = 2 at 500 Mev and 1200 Mev. (TTT)

12301 SYMMETRY OF STRONG INTERACTIONS AND THE CLASSIFICATION OF RESONANCES. V. M. Shekhter. p.103-15 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The symbols and terminology used to describe hadrons, or strong-interaction particles, are discussed. The quantum numbers are listed for the known hadrons (with masses up to 2360 Mev). The first 16 hadrons can be divided into two octets of pseudoscalar mesons ($\pi^+,\pi^-,\pi^0,\eta^0,K^+,K^0,\bar{K}^0,K^-$) and vector mesons ($\rho^+,\rho^-,\rho^0,\omega^0,K^{*+}$, K^{*0}, $\bar{K}^{*0}$,K^{*-}); any system of classification must include these 2 octets. Such a system is that of unitary multiplets, which allows groupings of 1, 3, 6, 8, 10, 15, 27, etc. The three-grouping includes proton, neutron, and Λ hyperon, and the corresponding antiparticles. The other mesons are found as bound states of baron-antibaron pairs, and 8 meson states are possible for 3-symmetry. For 8-symmetry 10-multiplets are possible. Most of the known hadrons are classified in the system. An Ω^- particle is predicted with a mass of 1585 Mev. Not all particles can be assigned, since the spins and parities are unknown. The consequences of other symmetries are discussed. (TTT)

12302 DISPERSION RELATIONS AND THE GENERAL PROPERTIES OF THE SCATTERING AMPLITUDES. N. M. Meiman. p.121-30 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The relativistic theory of a scattering amplitude A(z) which is analytic in the plane z with two cuts $(-\infty, -1)$ and $(+\infty, +1)$ along the real axis is presented. Along the cuts A(z) may contain a finite or infinite number of integrable singularities. The necessary and sufficient conditions for A(z) to obey a dispersion relation without correction terms are obtained if the Cauchy integral has a limiting transition at the boundary of the cuts. A conformal transformation maps the plane z inside a unit circle Z(|Z| < 1). It is shown that if Cauchy's formula applies in z it also applies on Z. The Cauchy integral converges if $A(z) < \epsilon$ for z approaching infinity. Other convergence criteria are discussed. (TTT)

12303 LOW-ENERGY $\bar{K}N$ SCATTERING AND Σ π-RESONANCE WITH A MASS OF 1405 Mev. V. M. Shekhter. p.116-20 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The possibility of considering the Σ_{1385} or Λ_{1405} resonance as a bound s-state in the $\bar{K}$-proton system is discussed. An analogy is made to the bound state (deuterium) in the p-n system. For a bound state to occur the scattering length A must be negative, and |A| must be large. Six parameters are necessary to describe the K-p system. The experimental values show that the isotopic spin of the 1400-Mev resonance I = 0. Since for Σ_{1385}, I = 1, the only possibility is the Λ_{1405} resonance (with I = 0). From K^-p and K^-d data the method of Dalitz is used to calculate the mass of a KN s_0-resonance of 1402 Mev, which is almost the mass of the Λ. Positive identification of the KN resonance with the Λ_{1405}, however, requires a knowledge of its spin and parity. (TTT)

12304 POLOLOGY AND REGGEOLOGY. L. B. Okun. p.133-46 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The basic idea of pole theory is that out of the innumerable diagrams which can be used to describe a strong-interaction process, one is chosen which corresponds to a change in one virtual particle. In pole theory: 1) two processes involving the same virtual particle have amplitudes with the same absolute value; 2) many amplitudes may be found by factorization of amplitudes for other reactions; 3) selection properties may be found from the quantum numbers of the virtual particle; 4) the virtual particle has definite isotopic spin; and 5) there is a universal relation between the pole amplitude and the energy (s) of the bombarding particle. Pole theory can not be applied to any arbitrary strong-interaction process, since it can not handle spins greater than unity. The amplitude is written in the form $s^L g^2/(t-\mu^2)$, where g is the interaction constant, t is the square of the momentum of the virtual particle, μ is its mass, and L is a whole number. According to Regge theory, the possibility of a change in spin is included by replacing s^L by $s^{\alpha(t)}$, where $\alpha(t) = L$ only if $t = \mu^2$. The rest of the amplitude is taken as the signature multiplier $\beta(t)$ csc $(\pi\alpha)(1 + \sigma e^{-i\pi\alpha})$, where the signature $\sigma = \pm 1$. It is shown that the product of the signature multiplier and $s^{\alpha(t)}$ (the Regge pole momentum) approach the pole theory amplitude as $\alpha \rightarrow n$, a whole number. Other properties of the Regge theory are discussed, and calculated results are compared with previously published experimental data. (TTT)

12305 BACKWARD SCATTERING AT HIGH ENERGIES. V. N. Gribov. p.147-56 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Regge theory may be viewed as diffraction from an object whose dimensions increase with increasing energy. Since diffraction occurs only in the forward direction, backscattering is not of interest. Regge theory assumes that the most important contribution to the scattering amplitude comes from the exchange of a virtual particle (Reggion) between two particles. The spin of R (=α) depends on the square of the transmitted momentum. The scattering amplitude $A(s,t) = r(t)s^{\alpha(t)}$. A(s,0) is purely imaginary. The quantity $\alpha(t) \rightarrow 0$ as $|t| \rightarrow \infty$: The amplitudes for the individual processes become much the same — no main process exists. The problem is resolved by recourse to the simpler pole theory. In backscattering, the Reggion is a fermion. Formulas for backscattering in the πN system are derived; the resulting amplitudes are complex. Experimental backscattering data would be useful in determining the spin and parity of the Reggion involved. (TTT)

12306 PRINCIPLES OF REGGE METHOD IN RELATIVISTIC THEORY. A. I. Larkin. p.157-65 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The assumptions involved in the formulae developed by Okun' and Gribov for the asymtotic scattering amplitude $A(s,t) = r(t)s^{\alpha(t)}$ are discussed. For the amplitude of the reaction $p_1 + p_2 \rightarrow p_3 + p_4$ to have cross-symmetry, all particles must belong to the same Feynman diagram. The use

of the Watson-Sommerfeld transformation is discussed for the case where A(t,s) is written as a sum of partial waves with amplitude $f_n(t)$. In nonrelativistic Regge theory, $f_n(t)$ is given by a Schroedinger equation; in relativistic theory a dispersion equation must be used. The unitarity of the amplitudes, resonances, and the asymtotic regime (large t) are also discussed. Experiments are needed to verify the cross-symmetry, the unitarity, the fact that the amplitude is analytic in the complex z-plane, and the existence of isolated poles. (TTT)

12307 P− P, π− P, P̄− P ELASTIC SCATTERING AT HIGH ENERGIES. Yu. D. Bayukov. p.166-80 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

When $S \gg 2M^2$, the cross section of elastic scattering at high energies in the forward direction is proportional to $\exp\{A(S)t\}$, where t is the transmitted momentum, S is the square of the total energy in cms coordinates, and A(S) is a linear function of $\ln (S/2M^2)$, where M is the mass of the bombarded nucleon. Previously published experimental data on elastic p− p, p̄− p, and π−p scattering at 10 to 20 Bev are reviewed and compared with theory. In general there is agreement to within 10 to 20%. One exception is the data for π⁻− p scattering, which varies from the theory because of a baryon resonance at 2 Bev/c. (TTT)

12308 PARTICLE PRODUCTION AND ELASTIC SCATTERING AT HIGH ENERGIES. K. A. Ter-Martirosyan. p.181-208 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Current theoretical work on the properties of reactions between strong-interaction particles at high energies is reviewed, based on Regge pole theory. Improvements in the Regge theory are discussed. Regge theory was verified only for elastic scattering, where it gives the cross section and has unitary properties according to the optical theory. The probability for particle formation (inelastic processes) is treated as the product of generation and absorption probabilities of a virtual meson (Reggion) and a scattering length. The formation of 2, 3, 4, and n particles is considered. Singularities of the particle-formation cross section (amplitude) in the complex j-plane are discussed. The position of the poles must be a function of $\sqrt{t}$, the transmitted momentum in the cms coordinates. For $t < 4m^2$ all singularities must lie symmetrically about the real axis of the j-plane, or on it. For $t < 0$ all singularities must lie left of the line $\mathrm{Re}(j) = 1$. If for $t < 0$ the poles lie on the real axis, they must move to the right with decreasing $|t|$. The cross section for 3-particle formation decreases less with energy than the elastic-scattering cross section. The formation of n particles may be considered as multiple decay of the Reggion along its line of flight. Decay may occur to single particles or groups of single particles. The energy of each emitted particle is usually proportional to its rest mass. The energy of the bombarding particles must be more than about 10 Bev for the asymtotic Regge theory to apply. (TTT)

12309 THRESHOLD CONDENSATIONS OF REGGE POLES. Ya. I. Azimov. p.209-19 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Regge poles are considered for the elastic scattering of two spinless particles with the same mass m. It is assumed that for the square of the total energy $t > 4m^2$ the scattering amplitude A(s,t,u) obeys a dispersion relation. Thus the partial amplitudes may be extended to any point on the complex l plane, by expanding them in terms of Legendre functions of the second kind. It is shown that the partial amplitudes f_l^s must have an infinite number of singularities for $\mathrm{Re}\, l \geq -\frac{1}{2}$. The necessary unitary conditions do not hold if there are only a finite number of singularities. The distribution of singularities (in complex pairs on the l-plane) is considered for $1/r^2$, square-well, and Yukawa potentials. Including a spin in an intermediate state of the scattering only shifts the results. As the energy is increased above the bunching threshold, another point is reached where the poles are again resolved. The tendency toward bunching is stronger the narrower the resonance of the state. (TTT)

12310 REGGE POLES AND PERTURBATION THEORY. A. A. Anselm. p.220-32 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The use of perturbation theory in calculating the trajectory of Regge poles in scattering from Yukawa potentials is discussed. In the nonrelativistic case, the trajectories are determined from the wave functions Ψ_l, which are solutions to Schroedinger's equation. The trajectories are expanded in terms of the binding constants, and their properties are discussed, using first-, second-, and third-order perturbation theory. In the relativistic theory of poles, it is not possible to write an equation for the pole trajectory in terms of a radial wave function with a given momentum. Here the trajectories are determined from the asymtotic behavior of the scattering amplitude in perturbation theory. If the binding constants are large (strong bonds), the trajectories can no longer be written in terms of the binding constants. For strong bonds, there also exist non-Regge poles. The results are applied to π-π scattering; backscattering is also discussed. (TTT)

12311 REGGE POLES FOR SCATTERING ON δ-POTENTIAL. G. A. Nagorskii. p.233-41 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The problem of scattering on a potential $U(r) = -g\delta(r-a)$ is considered, for cases in which the attraction $g = 0$. By means of the boundary transition $a \to 0$, $2ga \to 1$, the potential in the deuteron model may be derived from the δ-potential. In view of the simplicity of the δ-potential, motion of the poles, such as collisions and transitions to complex surfaces, may be conveniently investigated. The bound states of orbital moments $l < ga + \frac{1}{2}$ are defined by a single Regge trajectory. By solving the Schroedinger equation of the potential, an expression is obtained for the scattering S-matrix in the form of a function of the orbital moment. The location of the poles of the S-matrix on a complex surface was determined by means of known Bessel functions. The values obtained were found to be correct for any short-range potential which has no special feature at zero. (TTT)

12312 KINEMATICS OF COLLISIONS IN GEOMETRICAL INTERPRETATION. Ya. A. Smorodinskii. p.242-71 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Previous use of the geometry of Lobachevskii for the description of kinematics of relativistic particles is reviewed. A study is made of the connection of various group representations and methods of integral geometry with the representations of amplitudes frequently used in physics. Descriptions of relativistic kinematics and antiparticles using momentum and velocity spaces and kinematical diagrams are discussed. The use of parallel straight line and diverging straight line models for particle interactions is explained. Several examples are surveyed of the use of formulas of hyperbolic trigonometry—the decay of π^0 into 2 photons, the relativistic shift of angle at which two observers see a photon, the Doppler effect, the relativistic transformation of energy, and velocity mixing in Lobachevskii space. The Mandelstam parameters are defined, and crossing reactions are considered. Transformations of angular velocity and spin are discussed. An expression for Thomas precession from relativistic spin-orbit interactions is worked out. Helicity quantization, transition into crossing channels, and helicity mixing are described. The basic ideas of invariant expansion of amplitudes in Lobachevskii space are considered, with a discussion of expansions on spheres and on a cone. (M.J.T.)

12313 ESSENTIALLY SPECIAL POINTS IN THE COMPLEX PLANE OF ANGULAR MOMENTUM. V. N. Gribov. p.278-315 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

It was shown previously that a condensation should occur in the relativistic theory of completely negative moment values of the partial-wave amplitude, leading to essential

singular points. Thus the scattering amplitude A(s,t) in the crossing channel cannot decrease faster than 1/s. It was shown that consideration of the nuclear spin may lead to essential singularity in the case of l = 1; therefore the scattering amplitude in the crossing channel can not decrease at all high energies. This problem is reviewed in greater detail, considering the condensation of poles without taking spin effects into account. It is shown that the three Mandel'stam spectral functions limit the possible asymptotic behavior of the scattering amplitude. The essential singularities in the complex angular momentum plane are examined by means of a model in which the partial-wave amplitude jump at the left cut has the same properties as in the theory while the jump at the right cut is determined by the two-particle condition of singularity. The model allows the movement of the poles to be followed and the asymptotic character of the scattering in the crossing channel to be derived for a fixed but large transmitted pulse. If the jumps at the left cut tend toward zero, the model indicates that no branch points are formed at large –t values. (TTT)

12314 PARITY NON-CONSERVATION AND MACROSCOPIC ROTATION. Bruno Pontekorvo. p.319-23 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The problem of the rotation of a macroscopic body after absorption of a beam of polarized particles is reviewed using a recently developed theory. Various experiments were devised to show that the spin momentum of the polarized particles emitted during weak interaction processes is transformed into the moment of rotation of the macroscopic body. It is estimated that the rotational energy is only 10^{-18} ev. The thermal energy of the body is considered the source of the rotational energy; the kinetic energy of the electrons emitted during β decay could also contribute to this energy. In the general case, in which the electrons are not completely depolarized, the equilibrium state is derived from the conditions of conservation of the angular momentum and maximization of the entropy. The Coriolis field created by the rotation must be taken into account when calculating the spin momentum. (TTT)

12315 (REPORT) $K_2^0 \rightarrow 3\pi^0$ DECAY. A. M. Galper. p.324-9 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The $K_2^0 \rightarrow 3\pi^0$ decay was studied, using a 570-liter bubble chamber, filled with a 50-50 mixture of freon-12 and freon-13. The chamber was exposed to a synchrophasotron neutral particle beam. The K_2^0 beam passed through a Cu filter surrounding the accelerator. Studies were made of the decay of the K_2^0 particles and interaction of the K_2^0 particles with matter, including the generation of Λ hyperons without mesons and the determination of the total interaction cross section in Cu. It was attempted to demonstrate the decay of the K_2^0 particles into $3\pi^0$ mesons using pictures with 3 or more electron-positron pairs. (TTT)

12316 FORM-FACTORS IN WEAK INTERACTION PHYSICS. L. I. Lapidus. p.330-45 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The study of the decay processes of strongly interacting particles involving large momentum transfer and of high-energy neutrino processes require an understanding of the particle form factors. Only a few processes, such as the $\mu \rightarrow e$ decay, are able to dispense with strongly interacting particles. The problem form factors in μ-meson capture by nucleons, high-energy neutrino experiments, K_{e3} and $K_{\mu 3}$ decays, and hyperon β decays is reviewed. The beam theory of weak interactions served as the general framework of the review; the formula for the universal four-fermion interaction for charged beams and for symmetrical neutral beams was used. (TTT)

12317 SELECTION RULES IN DECAYS OF STRANGE PARTICLES. E. O. Okonov. p.346-60 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Gell-Mann and Nishijima explained the properties of K mesons and hyperons by means of a scheme involving isotopic-multiplet shift, introducing a new quantum number, strangeness (S). During the decay, a change of the strangeness results in changes of the isotopic spin. The originally postulated law of strangeness $|\Delta S| = 1$, which forbids the change of strangeness by 2 units, could not be easily verified because in most K meson and hyperon decays $|\Delta S| = 1$ appears to be the only possible change. More recently, data were obtained on processes in which the strangeness may change by 2 units: the transition $K^0 \leftarrow\rightarrow \bar{K}^0$ and the Ξ hyperon decay. Direct CP invariance leads to the following selection rules in K meson decays: the $K_2^0 \rightarrow \pi^+\pi^-$ and $K_2^0 \rightarrow 2\pi^0$ decays are forbidden because the combined parity of the $\pi^+\pi^-$ system is positive; the $K^0 \rightarrow \pi^{\pm}l^{\mp}\nu$ decays are permitted for both components K_1^0 and K_2^0; decay into $3\pi^0$ occurs only in the case of K_2^0; the $K_2^0 \rightarrow \pi^+\pi^-\pi^0$ is at least hundred times more probable than the corresponding decay of the short-lived K_1^0 meson. Results confirm CP invariance in the decay of strange particles. The conservation of parity in the various K-meson and hyperon decay processes should be further investigated. (TTT)

12318 DIAGRAM SUMMING METHOD IN THE PROBLEM OF THREE PARTICLES FOR SHORT-INTERACTING FORCES. A. M. Popova. p.373-85 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The diagram method of deriving the integral equation for the interaction amplitude of three low-energy particles is reviewed on the basis of the study on the short-range interaction of 3 nucleons of Skornyakov and Ter-Martirosyan, who showed that when the radius of interaction of the nuclear forces tends toward zero, the Schroedinger equation may be reduced to a single-variable function. The equation was examined by Danilov for the case of the three-body system, using a linear approximation method for r_0. The Kamarov and Popova investigated the inelastic scattering of nucleons on deuterons, taking the final-state interaction into account. It was found that the energy distribution of nucleons from the N + d reaction may be satisfactorily described by an approximation method, assuming that the total energy of the system is large in comparison with the binding energy of the deuteron while the momentum of the particles is small. The integral equation for the amplitude of the N + d reaction was derived, using the diagram summing method. The diagrams were compared with the matrix elements obtained by means of the perturbation theory involving wave functions. An analytic expression was obtained for the interaction of 3 nucleons, showing the contribution of the inelastic scattering of nucleons on deuterons to the amplitude in polar and triangular diagrams in the r_0 approximations. (TTT)

12319 THEORY OF INTERACTION OF THREE PARTICLES AT LOW ENERGY. G. S. Danilov. p.386-98 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

Low-energy interactions are examined as an example of the scattering of neutrons by deuterons. It is assumed that the inequality $k_0 r_0 \ll 1$ is valid, where k_0 is the pulse of the emitted neutrons and r_0 is the radius of action of the forces. If the prevailing conditions include not only $k_0 r_0 < 1$ but also $k_0 a_0 \ll 1$ (where a_0 is scattering amplitude at zero energy), the problem may be solved fairly simply. The questions studied involved cases for which $k_0 r_0 \ll 1$, or more generally, $k_0 a_0 \sim 1$. It is shown that the Skornyakov– Ter-Martirosyan equation, which determines the scattering amplitude of a neutron on a deuteron, does not have a well-defined solution. The generalized solution of this equation contains an energy-dependent arbitrary constant; it is similar to the two-body problem with coincident centers and leads to wave functions. When the distance between the particles tends toward zero, the wave function oscillates an infinite number of times. The center coincidence occurs only when the Pauli exclusion principle does not forbid the nucleons to be at the same point, i.e., when the total spin of the system, j, is equal to $\frac{1}{2}$. In the case of $j = \frac{3}{2}$, the equation possesses a

definite solution. Skornyakov and collaborators calculated the quartet length of the n–d scattering; the values obtained agreed with unpublished findings of Danilov et al. The case of $j = \frac{1}{2}$ is examined. The Skornyakov–Ter-Martirosyan equation was transformed, in order to obtain the value of the arbitrary constant; the derivation was made under consideration of the three-particle forces. (TTT)

12320 ELECTROMAGNETIC STRUCTURE OF NUCLEONS. G. M. Garibyan. p.401-15 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The structure of protons and neutrons is studied using high-energy electron scattering on nucleons. The Rosenbluth formula, the charge, the magnetic form factors of the nucleon and the isotopic form factor are discussed. It is attempted to derive an expression for the form factors, making use of the dispersion relations. The analytical properties of the form factors are considered as functions of the square of the complex transferred 4-momentum $q^2 = t$. It is pointed out that the Rosenbluth formula is not universally applicable. The behavior of electromagnetic form factors at high energies is examined. Experimental data indicate that the Dirac form factors of protons and neutrons tend toward a constant value for high values of $-q^2$. (TTT)

12321 INVESTIGATION OF THE NUCLEON ELECTROMAGNETIC FORM-FACTORS BY ELECTRON SCATTERING. V. M. Kharitonov. p.416-45 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

In the electron elastic scattering technique for investigation of electromagnetic form factors, the elastic scattering cross section is usually determined by means of the Rosenbluth formula, assuming that a single-photon exchange takes place. The form factors are calculated on the basis of the experimental differential cross sections by the intersecting ellipses method, or by the graphical method proposed by Wilson. Rosenbluth's formula refers to purely elastic scattering, but elastic and inelastic scattering are accompanied by the emission of photons and recoil protons. This radiation interferes with the angular correlation of the particles; the peaks of the energy spectrum become less pronounced in the low-energy region, and the peak amplitude is affected. The corrections that must be made depend on the angular and energy range of the measurements. Losses due to electron radiation in the target must also be considered. Experimental methods used for measuring scattering cross sections are reviewed, and data on proton and nucleon form factors are evaluated. (TTT)

12322 BREMSSTRAHLUNG AND PAIR PRODUCTION IN CRYSTALS. F. R. Arutyunyan. p.446-63 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The position of the maximum and minimum bremsstrahlung intensity depends on the direction of the electron motion with respect to the crystal axis; interference effects increase with increasing electron energy. The effect of the crystal structure on the cross section of electron-positron pair production by high-energy γ quanta and the polarization of the γ quanta formed by coherent bremsstrahlung in crystals were determined previously. Qualitative aspects of the interference phenomena in crystals are critically examined, comparing derived values with experimental data obtained in bremsstrahlung measurements in Si single crystals exposed to 600-Mev electrons and in other experimental studies. It is pointed out that by making use of the bremsstrahlung and pair-formation phenomena in crystals, quasi-monochromatic and partially polarized γ quanta may be obtained. (TTT)

12323 COMPTON EFFECT ON MOVING ELECTRON. V. A. Tumanyan. p.464-73 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

In the Compton effect on moving electrons, the photons formed during the scattering process are harder than the originally scattered electrons, making it possible to create γ beams in high-energy electron accelerators; the properties of these beams differ from those of beams formed by slowing down of electrons in matter. High-intensity beams of primary electrons may be obtained using ruby crystal laser systems. By scattering 6943Å laser photons on electrons with $\omega_{max} = 848$ Mev, the effect increases rapidly with increasing electron energy. It could be expected that with the use of lasers operating at shorter wave lengths, photons with energies close to that of the primary electrons could be obtained. The energy distribution of the scattered quanta differs markedly from the distribution in bremsstrahlung. It is possible to polarize the beam of hard γ quanta; the presence of highly polarized quanta makes it possible to obtain polarized electrons and positrons by the Compton effect and pair formation. Study of the polarized γ quanta may be helpful for solving problems of photoproduction and photodisintegration. (TTT)

12324 X-RAY GENERATION BY PROTON BOMBARDMENT. Andrew A. Sterk (American Machine and Foundry Co., Alexandria, Va.). 17p. (CONF-715-3).

From 13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 1964.

Some of the characteristics of x-ray generation by proton bombardment are described. This method is particularly suitable for soft x rays >10 Angstroms. Excitation efficiencies are equal to or better than with electron excitation, while the resulting spectrum consists of a single characteristic radiation line, but with complete absence of bremsstrahlung. Experimental results, the design of an instrument, and some applications are discussed. (auth)

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Refer also to abstracts 12058 and 12288.

12325 (ARL-64-167) QUANTUM ELECTRODYNAMICS WITHOUT INDEFINITE METRIC. A. Peres (Israel Inst. of Tech., Haifa). May 7, 1964. 15p.

The electromagnetic potentials $A_a(X)$ are quantized in such a way that their space components are hermitian and their time component anti-hermitian. On the other hand, the metric in Hilbert space and the hamiltonian are positive definite. The above formalism, which leads to the usual commutator $[A_a(x), A_b(y)] = ig_{ab}D_0(x-y)$, is shown to be Lorentz covariant. Physical states are those containing neither longitudinal nor scalar photons (rather than a symmetric combination of them, as in the usual theory). This definition is also Lorentz covariant. The S-matrix is not unitary, but satisfies $PS^*PS = P$, where P is the projection operator over physical states. In other words, the S-matrix is unitary over the subspace of physical states, this being sufficient for the interpretation of the theory. (auth)

12326 (JINR-E-1850) INVARIANT EXPANSIONS OF RELATIVISTIC AMPLITUDES AND SUBGROUPS OF THE PROPER LORENTZ GROUP. I. Fris and P. Winternitz (Joint Inst. of Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 18p. Dep.(mn).

All the conjugated classes of continuous subgroups of the proper Lorentz group are found, their invariants are investigated, and the question of their connection with coordinate systems, in which the variables in the Laplace equation in the Lobachevsky space are separable, is considered. A simpler example of the group of motions of an Euclidean plane is considered, so as to clarify the group theoretical properties of elliptic coordinates. (auth)

12327 (KFKI-64-4) A RELATIVITÁSELMÉLET PROBLÉMAKÖRE A LORENTZ-ELV MEGVILÁGITÁSÁBAN. C. ELÖADASA ALAPJAN KIDOLGOZTA. I. RESZ. (The Sphere of Interest of the Theory of Relativity, Considered from the Viewpoint of the Lorentz Principle. Part I). Lajos Jánossy and Tivadar Siklós (Magyar Tudományos Akadémia Központi Fizikai Kutató Intézete, Budapest). 1964. 49p. Dep.(mn).

The phenomena forming the basis of the theory of relativity are analyzed, in an attempt to derive the concepts needed for establishing a theory on the basis of a logical examination of the experimental results. The mathematical formulas thus obtained are similar to those in the Einstein theory of relativity, but their physical meaning is different; in addition, the philosophical connotations of the theory of relativity are eliminated. The classic experiments for determining the velocity of light, Maxwell's equations of electromagnetic fields, the homogeneous wave equations and the Doppler effect are discussed in great detail. The properties of the ether are examined on the basis of the assumption that its state of motion is different in various points of the Universe. Einstein's explanation of the Michelson-Morley experiment is rejected. Special attention is given to the problem of synchronizing watches in different systems. A new concept, the Lorentz system, is introduced and defined as an inertia system in a coordinate system, carrying out only translation movements; it moves with a constant, rotation-free translational velocity with respect to the ether. The values of time and distance are determined by means of light signals. The Lorentz systems are always related to a physical system; thus, in first approximation a laboratory located on the surface of the Earth may be considered a Lorentz system, if the effects of the rotation of the Earth are disregarded or compensated. (TTT)

12328 ENERGY CONSERVATION AS THE BASIS OF RELATIVISTIC MECHANICS. R. Penrose (Univ. of Texas, Austin) and W. Rindler. Am. J. Phys., 33: 55-9(Jan. 1965).

The relativistic theory of collisions of macroscopic particles is developed from the two axioms of energy conservation and relativity, by use of standard relativistic kinematics without assuming the mathematical expression for relativistic energy. Derivations are made of the equivalence of rest mass and rest energy, the usual mathematical expression for the total energy in terms of the rest energy, the conservation of 3-momentum, and the equivalence of total energy with inertial mass. All possible conservation laws of quantities described by the product of a scalar with a function of the speed are found. (auth)

12329 LOCALIZED STATES AND PARTICLE IMAGE IN RELATIVISTIC FIELD THEORIES. U. Schroeder (Universität, Frankfurt am Main). Ann. Physik (7), 14: 91-112(1964). (In German

States describing particles at definite locations were introduced into the quantum theory of relativistic fields (such as the Klein-Gordon field and the Dirac field) by employing three-dimensional Fourier transformations. These states, localized within the meaning of Newton and Wigner, are self-states of a particle-density operator with delta functions as eigenvalues and thus form the basis of the Hilbertian space. The developmental coefficients of the general state as defined by these basic vectors then become the amplitudes of the probability for finding a specific number of particles at a specific portion of the space. 25 references. (OTS)

12330 ROTATION MOVEMENT OF A DIELECTRIC FLUID IN AN ELECTROMAGNETIC FIELD. John Carstoiu (International Consultant Scientists Corp., Brookline, Mass.). Compt. Rend., 259: 2781-4(Oct. 28, 1964). (In French)

The rotation of a dielectric fluid carrying charges and moving as a solid body in an electromagnetic field is considered. The equations derived recall the Larmor theorem on the motion of the electron, hypotheses on the magnetic and rotating electron, and the theory of the shape of the earth. It was established that a rigid rotation of the fluid can develop a magnetic induction doublet. Cases in which the permeability would not be a constant at the interior of the material are proven. A demagnetization action is shown. (J.S.R.)

12331 PLASMA WAVES IN FILMS. Yu. A. Romanov (Gorkii Scientific-Research Inst. of Physics and Tech., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 828-37(1964). (In Russian)

The power spectrum of a plasma slab was investigated by the method of the kinetic equation assuming the mirror electron reflection by the plasma boundary. The given dispersive relations for the surface plasmons greatly differ from the analogous results by Kanasava. The reason for this difference is pointed out. The optical plasmons which give the main contribution to the transient radiation due to the specific damping, are shown to exist in thin films. (auth)

12332 THE ABSORPTION (RADIATION) OF ELECTROMAGNETIC WAVES BY CHARGED PARTICLES IN THE PRESENCE OF A STATIC MAGNETIC FIELD. I. A. Gilinskii and K. A. Ryazantsev (Novosibirsk State Pedagogical Inst., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 838-43(1964). (In Russian)

The electromagnetic wave absorption (radiation) by the charged particle placed in a magnetic field is considered. In some cases the frequency spectrum of absorption (radiation) is shown to be equidistant; this fact is used to explain the autoresonance mechanism of acceleration. The quantum and classical consideration of the resonance is given at high-harmonics. (auth)

12333 STRUCTURE OF THE EQUATIONS OF COSMIC ELECTRODYNAMICS AND THE PHOTON REST MASS. V. L. Patel (Univ. of New Hampshire, Durham). Phys. Letters, 14: 105-6(Jan. 15, 1965).

It is shown that results from the Explorer XII satellite on low frequency hydromagnetic waves can be used to estimate the mass of the photon, and consequently determine the structure of cosmical electrodynamics. (L.B.S.)

12334 ON THE STRUCTURE OF THE THREE PARTICLE COLLISION OPERATOR IN QUANTUM MECHANICS. P. Resibois (Université Libre Brussels). Phys. Letters, 14: 108-9(Jan. 15, 1965).

The collision operator for three incident free particles was investigated from the many body point of view. Using recent developments of non-equilibrium statistical mechanics, exact transport equations of the one particle distribution function are written in terms of a virial expansion involving n particle collision operators. (L.B.S.)

12335 DERIVATION OF SU_3 MASS SUM RULES BY S-MATRIX METHODS. S. N. Biswas, S. K. Bose, and L. K. Pande (University of Delhi). Phys. Letters, 14: 150-1 (Jan. 15, 1965).

A method designed to study effects due to deviations from SU_3 symmetry, within the framework of S-matrix theory, is described. The amplitude for pseudoscalar octet (P_8)–baryon octet (B_8) scattering is considered, the breaking of symmetry being ascribed to ($\omega_8-\omega_0$) mixing. First order mass formulas for the octet and decuplet of baryon states are derived. Remarks on additional information obtainable from this procedure are given. (L.B.S.)

12336 IRREDUCIBLE TENSORS FOR SU_3 GROUP. L. Banyai, N. Marinescu, I. Raszillier, and V. Rittenberg (Inst. of Physics, Bucharest). Phys. Letters, 14: 156-8(Jan. 15, 1965).

An expression for the irreducible tensor matrix elements and a compact formula for SU_3 Clebsch-Gordon coefficients analogous to the Wigner-Racah expression for SU_2 are derived. (L.B.S.)

12337 COUPLING OF INTERNAL AND QUANTIZED SPACE-TIME SYMMETRIES. Ephraim Fischbach (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 137: B642-4 (Feb. 8, 1965).

Commutation relations in the group LU_4, recently introduced by Kurşunoğlu for studying the coupling of internal and space-time symmetries, are examined in some detail. It is shown that the operators $\Gamma_{\mu 4}$ ($\mu = 1,2,3,4$) may be formally identified with the noncommuting coordinate operators x_μ of a quantized space-time proposed by Snyder. This identification removes certain difficulties arising from associating the $\Gamma_{\mu 4}$, instead, with the momentum operators p_μ. It

is also shown that the commutation relations $[p_\mu, p_\mu] = 0$ follow naturally from the introduction of quantization into LU_4, and that the notion of quantization provides an intuitive basis for understanding the coupling of space-time and internal symmetry groups. (auth)

12338 OPTICAL-MODEL AND MANDELSTAM REPRESENTATION. Roland Omnes (Univ. of California, Berkeley). Phys. Rev., 137: B653-7(Feb. 8, 1965). (UCRL-11626)

It is shown that it is always possible to find explicitly an optical potential which, when used in the eikonal approximation, fits a scattering amplitude satisfying the Mandelstam assumptions. The potential can be constructed by making a series of integral transformations on the momentum-transfer discontinuity of the amplitude. In the case in which the asymptotic behavior in energy of the amplitude is given by the Regge-pole hypothesis, it is shown that, although the range of the potential (behavior $e^{-\mu 0 r}$) is constant, the size of the interaction region increases with energy owing to the nonuniformity in energy of the asymptotic behavior of the potential as a function of distance. (auth)

12339 NON-REGGE SINGULARITIES IN A THREE-BODY MODEL. Victor A. Alessandrini and Roland L. Omnes (Univ. of California, Berkeley). Phys. Rev., 137: B681-8(Feb. 8, 1965). (UCRL-11617)

A special model is investigated to see if it is possible to extend the three-body scattering amplitude to complex values of the total angular momentum J by an integral equation with completely continuous kernel, or by extending Fredholm solution of the Faddeev equations from integral J to complex J. This model is a helium atom with infinitely heavy nucleus, neglecting the interaction between electrons and replacing the Coulomb potentials by a superposition of finite-range Yukawa potentials. One finds poles in J which depend not only upon the total energy but also upon the subenergies of the electrons. Accordingly, the problems stated above have no solution. (auth)

12340 POLES IN THE VERTEX FUNCTION, ZEROS OF THE PROPAGATOR, AND BOUNDS ON COUPLING CONSTANTS. Y. S. Jin and S. W. MacDowell (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 137: B688-95(Feb. 8, 1965).

Extending the arguments by Goebel and Sakita, it is shown in a general framework that a pole of the proper vertex function does not lead to a pole in the scattering amplitude. Connections between zeros of the propagator, poles of the proper vertex function, and upper bounds on the coupling constant are discussed in rather general terms as well as in terms of the Zachariasen model. By making use of the analytic continuation of the partial-wave scattering amplitude into the complex angular-momentum plane, a possible physical interpretation of the pole of the vertex function is given. (auth)

12341 FEYNMAN DIAGRAMS WITHOUT FIELD THEORY. Asher Peres (Israel Inst. of Tech., Haifa). Phys. Rev., 137: B696-7(Feb. 8, 1965).

A generalized quantum mechanics in which the number of particles is not given a priori in each problem, and, in particular, is not a constant of the motion is presented. The quantum-mechanical Hilbert space thus contains states with 0,1,2, ... particles. The interaction picture and the S matrix are introduced as usual. It is shown (assuming relativistic invariance) that the calculation of S-matrix elements can be performed by means of graphical rules identical to those of Feynman. (auth)

12342 WAVE FUNCTIONS OF NONLOCAL POTENTIALS: THE PEREY EFFECT. N. Austern (Univ. of Pittsburgh). Phys. Rev., 137: B752-7(Feb. 8, 1965).

An eigenfunction of an attractive nonlocal single-particle potential is always smaller inside the region of the potential than outside; the converse occurs for repulsive potentials. This is the Perey effect. Explicit formulas for the effect are derived for the case of motion in one dimension, and interpretive discussions of the effect are given. The derivation does not employ series expansions. It is argued that the effect can be understood in terms of the fundamental many-body theory from which the single-particle potential has (in principle) been derived. Some of the wave function lies in the channels which were eliminated in the course of that derivation. (auth)

12343 RELATIONSHIP OF THE FOLDY-WOUTHUYSEN TRANSFORMATION TO LORENTZ TRANSFORMATIONS. Herbert Jehle and William C. Parke (George Washington Univ., Washington, D. C.). Phys. Rev., 137: B760-? (Feb. 8, 1965).

The covariant spinor formalism of Infeld and van der Waerden and of Uhlenbeck and Laporte permits a simple interpretation of the relation between a Foldy-Wouthuysen transformation for a free particle and an associated pair of Lorentz transformations. (auth)

12344 FINITE QUANTUM ELECTRODYNAMICS: A FIELD THEORY USING AN INDEFINITE METRIC. M. E. Arons, M. Y. Han, and E. C. G. Sudarshan (Univ. of Rochester, N. Y.). Phys. Rev., 137: B1085-1104(Feb. 22, 1965). (UR-875-54)

A finite relativistic field theory of quantum electrodynamics is formulated; the theory involves as an essential element the use of an indefinite metric to remove the divergences. Two auxiliary fermion fields with anticommutation relations of opposite sign from the normal fermion field (electron) are coupled with the electron to the electromagnetic field in such a manner that any matrix element, calculated by a perturbation expansion, is finite. Although the new lagrangian is not explicitly gauge invariant, the electromagnetic field is quantized by a method that yields a propagator in the true Landau gauge, and it is shown that this is sufficient to insure that the physical vector particles are zero-mass transverse quanta (i.e., photons). The physical electron mass and the fine-structure constant are put into the theory, leaving only the masses of the two auxiliary fields as parameters. The effects of mass and charge renormalization are calculated (the former using a technique involving a Taylor expansion in the mass), and are required to be small so that there is no explicit contradiction to the validity of the perturbation expansion. The anomalous magnetic moment of the electron and the differential and total cross sections for Compton scattering are calculated and compared with experiment. A range of the auxiliary mass parameters is found for which the predictions agree with experiment and for which the expansion criteria are satisfied. Thus, a finite quantum electrodynamics is accomplished. (auth)

12345 NONGEODESIC MOTION IN GENERAL RELATIVITY. Asher Peres (Israel Inst. of Tech., Haifa). Phys. Rev., 137: B1126(Feb. 22, 1965).

An exact Einstein metric, having a point singularity, the strength of which is characterized by a parameter m, is constructed. The motion of the singularity is not a geodesic of the background space, even for $m \to 0$. (auth)

12346 ON GRAVITATIONAL COLLAPSE AND THE CREATION OF ENERGY. T. Y. Thomas (Indiana Univ., Bloomington). Proc. Natl. Acad. Sci. U. S., 52: 1313-15 (Dec. 1964).

The possibility of the creation of energy as a consequence of a state of extreme collapse of a material body is discussed. It is assumed that neither the metric coefficients $h_{AB}(x)$ nor their derivatives can become infinite at any point of the four-dimensional continuum of the general theory of relativity. It is seen that such infinite discontinuities can be prevented only by the occurrence of abrupt changes in the local metric structure of the nature of explosions. Conditions for gravitational collapse are defined by considering a spherically symmetric distribution of matter and the associated metric or Schwarzschild solution of the field equations. By viewing the purely gravitational theory involving the material energy tensor as a special case of the more general theory of gravitation and electromagnetism actually in force, it is found that charged and uncharged particles and electric and magnetic fields can be produced solely as

a result of the extreme collapse of a purely material body. This hypothesis is in agreement with observations of the radio galaxy M82. (M.J.T.)

12347 COORDINATES FOR THE QUANTUM-MECHANICAL THREE-BODY PROBLEM. W. Zickendraht (Technische Hochschule, Karlsruhe, Ger.). Proc. Natl. Acad. Sci. U. S., 52: 1565-7(Dec. 1964).

A coordinate system with simple symmetry properties applicable to the treatment of the quantum-mechanical three-body problem is described. Its properties are illustrated in the case of three equal masses, and indications of rapid convergence are reported. A form of the trial wave function in variational calculations with hard core potentials is tentatively suggested. (auth)

12348 CALCULATION OF NONLINEAR OPTICAL SUSCEPTIBILITIES USING DIAGRAMMATIC PERTURBATION THEORY. J. F. Ward (Univ. of Michigan, Ann Arbor) Rev. Mod. Phys., 37: 1-18(Jan. 1965).

The availability of intense electromagnetic fields produced by lasers stimulated experimental and theoretical investigations of nonlinear optical phenomena such as second-harmonic generation. Coefficients descriptive of such processes in a medium may be calculated in terms of the matrix elements and characteristic frequencies of the medium by conventional quantum-mechanical perturbation theory of sufficient order. Calculations of this sort for several specific cases were presented by Armstrong and others. A study is presented which applies diagrammatic techniques borrowed from field theory to the perturbation calculations, simplifying the algebra and offering some insight into the structure of the nonlinear processes. A convenient collection of results is provided for many of the nonlinear optical processes of present and potential interest. (auth)

12349 A REMARKABLE PROPERTY OF PLANE WAVES IN GENERAL RELATIVITY. Roger Penrose (Univ. of Texas, Austin). Rev. Mod. Phys., 37: 215-20(Jan. 1965).

The complete general-relativistic plane-wave spacetimes (gravitational, electromagnetic, or both) are examined in relation to the focusing effect they exert on null cones. The following remarkable property is then obtained. No spacelike hypersurface exists in the space-time which is adequate for the global specifications of Cauchy data. As a consequence, it is not possible to imbed a plane wave globally in any hyperbolic normal pseudo-Euclidean space. (auth)

12350 EVALUATION OF WAVE FUNCTION OF ANALYTICAL ENERGY. R. V. Vedrinskii. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 4, 81-2(July-Aug. 1964). (In Russian)

A solution for the Schroedinger equation was developed in terms of the Taylor series for the energy. A general term is estimated for the series at certain limitations of the potential and a logarithmic derivative was estimated. A calculation method was suggested for the wave function and its derivative. The method can be used with sufficiently weak potentials. (R.V.J.)

12351 IRREDUCIBLE REPRESENTATIONS OF THE SU_3 GROUP. V. B. Mandeltsveig. (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1836-46(Nov. 1964). (In Russian)

Formulas are derived which permit one to determine which irreducible components enter the direct product of two irreducible representations of the SU_3 group and also to determine their multiplicity. A formula for calculating the isotopic and hypercharge content of the irreducible representation is deduced by means of the Young scheme. (auth)

12352 DIELECTRIC SUSCEPTIBILITY OF A RESONANCE MEDIUM. A. I. Alekseev and V. M. Galitskii (Inst. of Engineering Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1893-1904(Nov. 1964). (In Russian)

An expression is obtained for the dielectric susceptibility of a medium consisting of a set of identical two-level quantum objects. The extreme cases of weak and strong fields are investigated in detail. The dependence of the dielectric susceptibility on amplitude of the electromagnetic field is found in the latter case. A general solution of the closed equation set for the vector potential, polarization current, and level overpopulation is obtained without taking into account pumping and relaxation losses. The frequencies of the proper oscillations in a resonance medium in weak and strong fields are determined. (auth)

12353 SOLUTION OF THE GRAVITATION EQUATIONS FOR A HOMOGENEOUS ANISOTROPIC MODEL. A. S. Kompaneets and A. S. Chernov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1939-44(Nov. 1964). (In Russian)

Solutions of the Einstein equations for a homogeneous axial-symmetric model are derived in two limiting cases for dust-like matter and an ultrarelativistic gas. The solutions possess a singularity for a certain value of time but for the equation $\epsilon = 3p$ they can be conjugated analytically at both sides of the singularity. A solution for a nonrelativistic gas with a constant isentropy index is also derived. (auth)

12354 SPIN KINEMATICS IN LOBACHEVSKY SPACE. A. M. Khromykh (Inst. of Physics and Tech., Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2150-8(Dec. 1964). (In Russian)

Transformation of particle spin functions, that is, the spin kinematics in space of relative particle velocities which is a Lobachevsky space is studied. The Q-representation for spin functions is introduced for which the rotational group operator matrix is the same as the operator matrix of the particle velocity stationary subgroup. Discrete transformations in the Q-representation are considered. As an example the technique developed is employed for setting up the amplitude and density matrix of the final state for the Compton effect. The relation between observables for elastic scattering and the annihilation reaction is considered. (auth)

12355 ON THE EQUATIONS OF QUANTUM FIELD THEORY. V. Ya. Fainberg (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2285-97(Dec. 1964). (In Russian)

A formulation of the fundamental axioms of quantum field theory is proposed which differs somewhat from the usual one. One of the axioms is the condition of minimum singularity of the current and field operator commutator at coinciding times. Microcausality and the existence of a unitary S matrix are consequences of the intial axioms of the theory. A set of closed equations for the S matrix elements can be derived from the axioms which are extrapolated beyond the mass shell with respect to only one of the external 4-momenta. In order to exclude indeterminate subtraction terms, the equations are written down in an integrodifferential form (in momentum space). This form permits one, in particular, to formulate the boundary conditions and to show that the number of independent constants, the charges, which enter the equations apart from the particle masses, exactly equals the number of matrix elements which do not vanish for any mode of the invariant variables approaching infinity. An iteration solution of the equations is identical with the renormalization series in perturbation theory. (auth)

12356 TOPICS IN QUANTUM ELECTRODYNAMICS. G. Kaellen (Univ. of Lund, Sweden). p.123-262 of "Elementary Particle Physics and Field Theory. Vol. 1." New York, W. A. Benjamin, Inc., 1963.

The properties of free Dirac and electromagnetic fields are outlined, and the interaction of the quantized electron and electromagnetic fields is studied. The vacuum polarization, anomalous magnetic moment of the electron and meson (μ), Lamb shift, and electron-proton scattering cross section are calculated using different invariances and causality. (D.C.W.)

12357 OPERATOR STRUCTURES IN SU_3 WITH AN APPLICATION TO TRIPLETS. G. E. Baird and L. C. Biedenharn (Duke Univ., Durham, N. C.). p.58-69 of "Symmetry Principles at High Energy." San Francisco, W. H. Freeman and Co., 1964.

A classification of operator structures within the SU(3) group is presented. The concept of triality for Su(3) representations is used to show that the existence of triplet SU(3) representations does not necessarily require the introduction of fractional charge or of fractional baryon or strangeness quantum numbers. (D.C.W.)

12358 THE THEORETICAL SIGNIFICANCE OF EXPERIMENTAL RELATIVITY. R. H. Dicke. Documents on Modern Physics. New York, Gordon and Breach Science Publishers, 1964. 163p.

The performance, results, and implications for gravitation theory of some relativity experiments are discussed. Twelve papers on related topics in gravitation theory and cosmology are included. (D.C.W.)

12359 UNITARY REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP INCLUDING REFLECTIONS. E. P. Wigner (Inst. for Advanced Study, Princeton, N. J.). p.37-80 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

A review on the restricted Poincare group, the quantum mechanical restricted Poincaré group, and their representations is presented first. The Poincaré group which contains space, time, and space-time reflections is then described; and the groups formed by the related quantum mechanical operators are analyzed. The representations of the group of quantum mechanical operators that correspond to proper Poincaré transformations and to transformations involving space reflections are determined, together with the antiunitary operators which correspond to time and space-time inversions. A physical interpretation is attempted. (D.C.W.)

12360 LECTURES ON SPIN AND STATISTICS. N. Burgoyne (Univ. of California, Berkeley). p.81-99 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

The connection of spin with statistics is considered from the viewpoint of axiomatic field theory. The axions are discussed, and the spin-statistics theorem is proved. Other approaches to spin-statistics are indicated. (D.C.W.)

12361 LECTURE ON THE TCP AND CROSSING SYMMETRIES. N. Burgoyne (Univ. of California, Berkeley). p.101-6 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

Proofs of crossing and TCP symmetry are outlined, after a brief consideration of the implications of the symmetries for some interactions. (D.C.W.)

12362 INVARIANCE IN QUANTUM MECHANICS AND GROUP EXTENSION. Louis Michel (Institut des Hautes Etudes Scientifiques, Sero, France). p.135-200 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

The mathematical problem of group extensions is developed. Central extensions of the connected Poincaré group by an arbitrary abelian group are characterized; and the corresponding extensions for the complete Poincaré group, including P, C, and T are presented. The generalization to extensions by a nonabelian group is also considered. (D.C.W.)

12363 BROKEN SYMMETRIES. Abdus Salam (Imperial Coll. of Science and Tech., London). p.359-64 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

The consequences are considered of the breakdown of symmetry based on the hypothesis that sets of equations which depend symmetrically on a number of parameters (masses or coupling constants) may possess not only the trivial symmetric solutions for these parameters but also other solutions which are nonsymmetric. The essential result of the breaking of a continuous symmetry in this self-consistent manner is the apparent introduction of massless fields. (D.C.W.)

12364 INTRODUCTION TO THE DE SITTER GROUP. Feza Guersey (Middle East Tech. Univ., Ankara). p.365-89 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

The basic properties of the de Sitter group are reviewed, and a formalism is presented for handling the transformations. The expressions for the operators that replace energy and momentum are derived, and the invariants of the group are obtained. Dirac's de Sitter invariant equation for spin-½ fields is derived, together with invariant equations for spin 0 and 1. Improper transformations are briefly considered. (D.C.W.)

12365 PARASTATISTICS: AXIOMATIC FORMULATION, CONNECTION WITH SPIN AND STATISTICS AND TCP THEOREM FOR A GENERAL FIELD THEORY. G. F. Dell' Antonio, (Università, Naples), O. W. Greenberg, and E. C. G. Sudarshan. p.403-7 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

A quantum field theory of free particles obeying parastatistics is discussed, together with the axiomatic formulation of parastatistics. It is shown that the assumption of paralocality leads to a generalization of the TCP theorem for paralocal fields. A generalization of the connection of spin and statistics is also demonstrated. (D.C.W.)

12366 THE RENORMALIZATION GROUP. E. R. Caianiello (Università, Naples), p.409-25 of "Group Theoretical Concepts and Methods in Elementary Particle Physics." New York, Gordon and Breach, 1964.

The dynamics and structure of field theories were studied with particular consideration of the renormalization group. Electrodynamics was treated as an example, and the bases for u-v divergences were investigated. (D.C.W.)

12367 GRAVITATION AND RELATIVITY. Hong-Yee Chiu and William F. Hoffman, eds. Physical Investigations of the Universe. New York, W. A. Benjamin, Inc., 1964. 388p. $15.75.

Separate abstracts were prepared for fourteen of the fifteen chapters. The other chapter was previously abstracted for NSA 18: 2720. (D.C.W.)

For abstracts of individual chapters see: 11860, 12057, 12058, 12059, 12060, 12368, 12369, 12370, 12371, 12372, 12373, 12374, 12375, and 12376.

12368 REMARKS ON THE OBSERVATIONAL BASIS OF GENERAL RELATIVITY. R. H. Dicke. p.1-16 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The experimental bases for gravitational theories, particularly general relativity, are discussed. It is shown that the observational support for general relativity is insufficient to eliminate other possible theories of gravitation. (D.C.W.)

12369 RIEMANNIAN GEOMETRY. J. L. Anderson. p.17-39 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

A brief survey of tensor analysis and differential geometry is presented. The four-dimensional Riemannian geometry specifically is discussed. (D.C.W.)

12370 GRAVITATION AS GEOMETRY. I. THE GEOMETRY OF SPACE-TIME AND GEOMETRODYNAMICAL STANDARD METER. Robert F. Marzke and John A. Wheeler. p.40-64 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The structure of Riemannian geometry is defined without recourse to the concept of coordinates. A technique is

given for relating one distance or invariant space-time interval to another, using for the intercomparison only the paths of light rays and material particles. (D.C.W.)

12371 GRAVITATION AS GEOMETRY. [PART] II. John A. Wheeler. p.65-89 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The bases for the selection of allowed Riemannian geometries from among conceivable Riemannian geometries are outlined. (D.C.W.)

12372 GRAVITATIONAL WAVES. J. Weber. p.90-105 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The theoretical evidence for the existence of gravitational waves is outlined, and the detection of gravitational waves is discussed. Detection using laboratory equipment, the earth, and the moon as detectors is considered, together with generation of gravitational waves in the laboratory. (D.C.W.)

12373 THE MANY FACES OF MACH. R. H. Dicke. p.121-41 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The implications and interpretation of Mach's principle in gravitation theory are discussed. Fields for expressing the laws of gravitation in a manner compatible with Mach's principle are considered. (D.C.W.)

12374 RELATIVITY PRINCIPLES AND THE ROLE OF COORDINATES IN PHYSICS. J. L. Anderson. p.175-94 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The principles of special and general relativity are discussed, together with determination of the relativity principle for a given theory. The concept of preferred coordinates is also considered, together with the relation between the invariance properties of a theory and the conservation laws associated with the theory. (D.C.W.)

12375 GRAVITATION AND LIGHT. J. Weber. p.231-40 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The interaction of light with a gravitational field is studied. Gravitational deflection of light is treated by both relativistic and nonrelativistic methods, and the effect of the photon spin is indicated. The theories of Einstein and Maxwell are compared; and geometrization of electrodynamics, quantization of the coupled Maxwell-Einstein fields, and the gravitational red shift are considered. (D.C.W.)

12376 QUANTIZATION OF GENERAL RELATIVITY. J. L. Anderson. p.279-302 of "Gravitation and Relativity." New York, W. A. Benjamin, Inc., 1964.

The classic Hamiltonian formulation of general relativity and electrodynamics is discussed, and two approaches to quantization of these theories within the Hamiltonian framework are outlined. Conceptual problems associated with quantization of general relativity are also discussed. (D.C.W.)

12377 MEZHDUNARODNAYA ZIMNYAYA SHKOLA TEORETICHESKOI FIZIKI PRI OB'EDINENNOM INSTITUTE YADERNYKH ISSLEDOVANII. KURS LEKTSII. TOM I. (National Winter Semester School of Theoretical Physics at the Joint Institute for Nuclear Research. Vol. I, 1964). Dubna, USSR, Joint Inst. for Nuclear Research, 1964. 170p.

Lectures on the basic principles and results of a systematic approach to the relativistic quantum theory are presented. Data on functional analysis, the theory of generalized functions, invariability of nonhomogeneous Lorentz groups, and spectrality are surveyed as well as the determination and properties of local quantized fields. Properties of the Wightman function, the Hall-Wightman theorem for Lorentz invariant functions, the TCP theorem, asymptotic conditions, and the S matrix are discussed. The Borchers equivalence classifications and generalized free fields are also discussed. (R.V.J.)

12378 MEZHDUNARODNAYA ZIMNYAYA SHKOLA TEORETICHESKOI FIZIKI PRI OB'EDINENNOM INSTITUTE YADERNYKH ISSLEDOVANII. KURS LEKTSII. TOM II. (National Winter Semester School of Theoretical Physics at the Joint Institute for Nuclear Research. Vol. 2, 1964). Dubna, USSR, Joint Inst. for Nuclear Research, 1964. 180p.

Seven articles are included on quantum field theory and dispersion theory of low energy pion-pion scattering. Separate abstracts are prepared for each article. (R.V.J.)

For abstracts of individual sections see: 12292, 12293, 12379, 12380, 12381, 12382, and 12383.

12379 A FUNCTIONAL METHOD FOR QUANTUM FIELD THEORY. E. S. Fradkin. p.5-37 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom II." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

Applications of functional methods in field theory are analyzed considering certain solutions different from the ordinary perturbation theory. Various aspects of field theory are discussed in relation to the Lagrange, axiomatic, and dispersion methods. An operator S matrix satisfying all axiomatic principles in the quantum field theory was developed by means of the generating functional Z. General relations which in Green's functions express the unitarity, causality, and spectrality of the constructed field theory coincide with similar relations postulated in the axiomatic approach to field theory. Dynamic equations for generating the functional operation solution for the Z functional equation system and the modified perturbation theory for the Green's function are discussed. (R.V.J.)

12380 GENERAL PRINCIPLES OF QUANTUM FIELD THEORY AND THE EXPERIMENTAL DATA. A. A. Logunov and Nguyen-Van-Hieu. p.38-65 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom II." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

Asymptotic relations for scattering amplitudes in local field theory were studied using scalar particle scattering as an illustration of the deduction method. The method was also used in the investigation of scattering and photoproduction processes. Asymptotic properties of scalar particle and meson-baryon scattering amplitudes were analyzed as well as the asymptotic properties of the photoproduction and Compton effect amplitudes. Analytical properties of the form factors suggested certain conclusions relating to (strong-interaction) form factor asymptotics. Asymptotic relations for crossing processes were derived on the basis of local quantum field theory and on the general assumption of scattering amplitude behavior at $s \to \infty$ and fixed t. The obtained amplitude relations were used for determining a series of asymptotic relations for differential and total cross sections and asymmetric polarizations and parameters. (R.V.J.)

12381 QUASI-POTENTIAL METHOD AND QUANTUM FIELD THEORY. A. N. Tavkhelidze. p.66-79 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom II." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

A concept of a potential was introduced into the quantum field theory in order to study bound states and scattering problems. It is shown that the system of two interacting particles in quantum field theory can be described by the Schroedinger equation in momentum space and a generalized complex potential $V(E; \vec{p},\vec{p}')$ which is a function of energy. A potential construction algorithm is given in case of a coupling constant. Analyticity properties of the 2-time Green function in the quantum field theory were used in determining the conformity of the imaginary part of the quasipotential. (R.V.J.)

12382 THE THEORY AND GENERALIZATION OF POTENTIAL SCATTERING. A. F. Filippov. p.80-107 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki

pri Ob'edinennom Institute Yadernykh Issledovanii. Tom II." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

Simple generalizations of the potential scattering theory and quasipotential scattering amplitudes are reviewed. Applications of Fredholm's method in potential scattering are evaluated. (R.V.J.)

12383 SPIN AND SYMMETRY OF INTERACTIONS. V. I. Ogievetskii and I. V. Polubarinov. p.160-80 of "Mezhdunarodnaya Zimnyaya Shkola Teoreticheskoi Fiziki pri Ob'edinennom Institute Yadernykh Issledovanii. Tom II." Dubna, USSR, Joint Inst. for Nuclear Research, 1964. (In Russian)

Space-time homogeneity and isotropy are expressed by the field theory invariability in relation to the nonhomogeneous Lorentz group (Poincaré group). The conservation law of energy, momentum, and angular momentum is the direct result of the invariability. It is shown that the space-time properties are also related to the law of conservation of electric and baryon charges and of isotopic spins. A preliminary study was made of the nonhomogeneous Lorentz group and the concept of interacting field spin in the nonhomogeneous Lorentz group. (R.V.J.)

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Refer also to abstracts 12043, 12049, 12052, 12668, 12688, and 12693.

12384 (AD-422548) ATMOSPHERIC PARAMETERS FOR FOUR QUIESCENT EARTH CONDITIONS. Report No. 132. W. E. Sims and F. X. Bostick (Texas. Univ., Austin. Electrical Engineering Research Lab.). Sept. 1, 1963. Contract Nonr 375(14). 27p. $3.60(OTS).

Seven parameters are tabulated as functions of altitude and magnetic latitude for four different quiescent earth conditions. The conditions include daytime and nighttime for periods of maximum and minimum sunspot activity. The seven parameters tabulated are the geomagnetic field intensity, the gyrofrequencies of electrons and ions, the plasma frequency, and the collision frequencies between electrons, ions, and neutral particles. (auth)

12385 (AFCRL-63-747) SOME EXPERIMENTAL STUDIES OF THE IONOSPHERIC D REGION AT HIGH LATITUDES. Technical Note No. 3. O. Holt (Norway. Forsvarets Forskninginstitutt, Kjeller). July 31, 1963. Contract AF61(052)-599. 105p. (AD-424118). $9.10 (OTS).

Some experimental studies of the ionospheric D region are presented. The observations were made between 1958 and 1962. The routine observations of cosmic radio noise at 27.6 MHz were made by riometers at several stations. Electron densities in the lower part of the D region were determined from the observations of partially reflected radio waves at 2.3 and 2.7 MHz during different ionospheric conditions. The experimental methods are discussed and the equipment is briefly described. The primary purpose of the investigations was to study the different types of radio wave absorption occurring at high latitudes, but some observations made during sudden ionospheric disturbances, which are not limited in latitude, and during normal conditions, are also included. The theory of ionization and recombination in the D region is briefly reviewed, and when possible, agreement with the observations is discussed. The different types of absorption are treated separately. The variation of electron density in the D region during twilight conditions is discussed. (auth)

12386 (NSA-TR-R-143) SPECTRUM OF HYDROMAGNETIC WAVES IN THE EXOSPHERE. Gordon J. F. MacDonald (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Dec. 1962. 62p. (N64-16006). $1.75(OTS).

A disturbance in the exosphere generates waves in three partially separable modes. These modes are described by considering the vorticity about a line of force, the two-dimensional divergence of velocity in the plane perpendicular to the line of force, and the component of velocity along the line of force. The propagation of vorticity is one-dimensional, and there is no geometrical attenuation; energy is lost only through the finite conductivity of the medium. The propagation of the longitudinal velocity component is almost one-dimensional but is heavily damped at high frequencies. In a gravitational field the medium is no longer uniform, and at low frequencies the modes are coupled in a complicated way. For parallel magnetic and gravitational fields, the vorticity mode is still separable, and gravity leads to anisotropic dispersion in the other modes. (auth)

12387 SOLAR CORPUSCULAR STREAMS AND GEOMAGNETIC STORM FAMILIES DURING THE FLIGHT OF "MARINER-2." V. I. Afanas'eva (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 24-39(1964).

Data from plasma measurements on Mariner-2 are used to verify the hypothesis of geomagnetic storm families. The results obtained indicate that a family of geomagnetic storms may be associated with the interaction of a single solar corpuscular stream with the geomagnetic field. Such a stream passing by Mariner-2 caused an increase in the velocity of plasma, which was recorded on the probe. (auth)

12388 ESTIMATE OF THE SLOPES OF SURFACES OF EQUAL ELECTRON CONCENTRATIONS IN THE IONOSPHERE FROM DATA ON IONIZATION DISTRIBUTION WITH HEIGHT. T. S. Kerblay and Z. V. Voloshinova (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 45-8(1964).

Data are presented for the slopes of surfaces of equal electron concentrations. Slopes stemming from the difference in height of various electron concentrations h_{N_c} at various longitudes as a result of different illumination and of the latitudinal distribution of h_{N_c} are examined. The maximum angles of slope obtained are 2 to 3° in the first case and 3 to 5° in the second. The angles of slope were computed from N(h) profiles for several stations located at different latitudes and from world maps of h_m and y_m. It is found that the maps yield absolute slopes that are much smaller than the slopes obtained from N(h)-profiles, but the time of appearance of the slopes and their signs coincide. The conclusion is reached that h_m and y_m maps, converted to h_{N_c} maps, can be used to estimate the effect of slopes on short wave propagation. A sample computation of the maximum usable frequency of radio links, taking into account the slopes of surfaces of equal electron concentration, is presented. (auth)

12389 SPORADIC E-LAYER AT HIGH LATITUDES DURING MAGNETIC DISTURBANCES. E. E. Goncharova (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 49-54(1964).

The behavior of the E_s layer at northern latitudes during magnetic disturbances is examined. It is shown that E_s appears much more frequently at night during magnetic disturbances than during magnetically quiet days. The behavior of various types of E_s during magnetic disturbances and the dependence of the frequency of appearance of E_s with continuous reflections of different duration on the degree of the magnetic disturbance are also examined. (auth)

12390 SEASONAL VARIATION OF THE SPATIAL DISTRIBUTION OF IONOSPHERIC DISTURBANCES AT THE HIGH LATITUDES OF THE NORTHERN AND SOUTHERN HEMISPHERES. R. A. Zevakina (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 61-6 (1964).

The seasonal variations of synoptic charts of anomalous absorption, of E_s with high limiting frequencies ($fE_s > 4$ Mc), and of positive and negative deviations of f_0F_2 of more than

20% from the median are examined for the northern and southern hemispheres. It is shown that anomalous variations of f_0F_2 are less frequent and occupy much smaller areas in the summer than in the winter hemisphere. Anomalous absorption, which is observed simultaneously in both hemispheres, appears earlier and spreads over a considerably larger area in the summer than in the winter hemisphere. E_s regions with high cutoff frequencies are more stable and occupy a much larger area in the northern hemisphere, regardless of season. (auth)

12391 SOME IONIZATION PROCESSES IN THE F REGION OF THE IONOSPHERE DURING THE SOLAR ECLIPSE OF 1961. N. P. Danilkin (Rostov-on-the-Don State Univ., USSR). Geomagnetism Aeronomy, 4: 76-80 (1964).

Variations in electron density at various heights and at the maximum of the F region over Sofia and Sverdlovsk are reported. A decrease in electron concentration was found in all cases during the eclipse. It is shown that electrons are transported vertically at the 140-km level, according to the data for Sofia. Some ionospheric parameters are reviewed as a function of the progress of the eclipse and of the location of the station with respect to the path of the total phase of the eclipse. (auth)

12392 INTERMEDIATE E-F REGION OF THE IONOSPHERE DURING THE TOTAL SOLAR ECLIPSE OF FEBRUARY 15, 1961. K. B. Serafimov (Geophysical Inst., Bulgarian Academy of Sciences, Sofia). Geomagnetism Aeronomy, 4: 81-5(1964).

The theoretically expected changes in the state of the E_2 layer during a solar eclipse are examined. The results of investigations of the intermediate E-F region (E_2 and F_0 layers) during the solar eclipse of February 15, 1961, are reported. The eclipse effect in the intermediate E-F region is demonstrated on the basis of analysis of data for control days and data from the network of stations in Eastern and Western Europe. This effect consists in the decrease of the critical frequencies of the E_2 and F_0 layers and in the disappearance of reflections from them. It is assumed that the observed phenomena result from changes in dynamic processes in the ionosphere during an eclipse. (auth)

12393 APPLICABILITY OF THE MAIN CONCLUSIONS OF STORMER'S THEORY TO THE EXPLANATION OF SOME PATTERNS OF MAGNETIC DISTURBANCES AT HIGH LATITUDES. A. P. Nikol'skii (Arctic and Antarctic Scientific Research Inst., USSR). Geomagnetism Aeronomy, 4: 106-12(1964).

The diurnal distribution of irregular magnetic disturbances is investigated on the basis of the results of variation observations made over a period of 145 months from 1950–1960 at drifting stations and at Tikhaya, Chelyuskin, and Wellen. It is shown that there is a fourth, after-midnight, maximum in the diurnal distribution of irregular magnetic disturbances. If the effective region of particle emission (zone where solar particles are captured by the geomagnetic field) is taken to be the region located in the plane of the geomagnetic equator and displaced 30° to the east of the sun, the observed times of the four maxima, as reduced to the geomagnetic time relative to this source, practically coincide with the theoretical times of impact zones on Störmer's particle precipitation spiral. The fluctuations in the times of appearance of irregular disturbances are, apparently determined by a change in the position of the effective radiation source relative to the earth. The daily number of maxima and their relative intensity depend on the distribution of particles in the capture zone along parameter γ and the day-to-day variations of this distribution. (auth)

12394 SYNTHESIS OF THE GEOMAGNETIC FIELD FROM SPHERICAL HARMONIC COEFFICIENTS. N. V. Adam, N. P. Ben'kova, V. P. Orlov, N. K. Osipov, and L. O. Tyurmina (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR and Inst. of Mathematic and Computation Center, Academy of Sciences, Siberia). Geomagnetism Aeronomy, 4: 113-20(1964).

Results are reported of computations of geomagnetic elements X, Y, Z, and T for 1955 from coefficients of spherical analysis. Maps compiled at the IZMIRAN and at the British Admiralty served as source material. The synthesized values are compared with the initial data. It is concluded that the coefficients can be used to compute the magnitude of the magnetic field at great heights. A magnetic field is found which is determined by sources outside the earth. At the surface of the earth the outer part of the field averages only 0.6% of the entire geomagnetic field. (auth)

12395 LATITUDINAL AND SEASONAL DISTRIBUTION OF MAXIMUM AND MINIMUM DIURNAL f_0F_2 VALUES. N. M. Boyenkova (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 132-6(1964).

The behavior of critical F_2-layer frequencies—$f_0F_{2\max}$ and $f_0F_{2\min}$—was examined, using monthly median values of f_0F_2 from 80 stations for 1958. The behavior of the frequencies was analyzed as a function of the geographical latitude of the observation site for three seasons—winter (January), equinox (March), and summer (July)—for various positions of the sun and times of day; results are presented and discussed. (M.J.T.)

12396 VARIATION IN THE HEIGHTS OF MAXIMUM ELECTRON CONCENTRATION IN THE F_2 REGION. T. A. Anufrieva (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 137-40(1964).

The geographical distribution of h_{max} deviations from the median values on quiet and disturbed days is studied, and the probability of various temporal h_{max} variations at different latitudes is examined. Data from 39 stations of the world network, at 70°N to 70°S latitude, from 1958–60 were used. Analysis was made of the scatter of h_{max} values around the average monthly curve for data from individual stations, of synoptic Δh_{max} charts for quiet and disturbed days, and of the temporal variation of Δh_{max} in quiet and disturbed periods. (M.J.T.)

12397 EFFECT OF ELECTRON-ION COLLISIONS ON THE DIFFUSION OF ELECTRON-CONCENTRATION INHOMOGENEITIES IN THE IONOSPHERE. G. I. Grigor'ev (Gorkii State Univ., USSR). Geomagnetism Aeronomy, 4: 140-1(1964).

The ambipolar diffusion of isothermal plasma in a constant magnetic field is examined, taking into account the frequency of electron-ion collisions. Derivations from the system of quasi-hydrodynamic equations of motion and continuity equations of electron and ion gases are used to show that the rate of transverse diffusion is considerably higher than that obtained without allowance for the electron-ion collision frequency. (M.J.T.)

12398 LATITUDINAL CHANGE OF THE DIURNAL VARIATION OF FREQUENCY OF OCCURRENCE OF THE F1 LAYER. L. A. Shchepkin (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, Siberia). Geomagnetism Aeronomy, 4: 141-4 (1964).

Conclusions of a previous study on conditions for occurrence of the F1 layer, by investigating the diurnal variation of the frequency of its occurrences, are confirmed and supplemented. Data for approximately 100 stations in the northern and southern hemispheres, for the epoch of high solar activity (1957-9) at the times of the solstices, were used. A coefficient of asymmetry is defined and determined as a function of latitude. It is found that at latitudes from 50 to 70° the conditions for formation of the F1 layer are more favorable in the morning than in the evening hours; at other latitudes there is genèrally a reverse pattern of diurnal variation. (M.J.T.)

12399 THE CHARACTER OF AURORAS OBSERVED IN THE NEAR-POLAR REGION. L. S. Yevshalin (Polar Geophysical Inst., Academy of Sciences, Kola, USSR). Geomagnetism Aeronomy, 4: 144-6(1964).

A study was made of spectrographic data on Antarctic

auroras, recorded for 130 nights at Vostok station in 1959. Of the 82 nights on which spectral lines were recorded, the red 0 line predominated over the green one in 75% of the cases; thus type-A red auroras of low brightness predominate in the near-polar region of the southern hemisphere, as well as in the northern hemisphere. A correlation was made between the temporal changes of spectral characteristics recorded at Heiss Island during the season 1958-9 and the variations of the geomagnetic field. High auroras are observed at quiet magnetic field, and bright auroras of green color correlate with magnetic disturbances. (M.J.T.)

12400 SOME RESULTS OF VISUAL AURORAL OBSERVATIONS AT TIXIE BAY. N. I. Dzyubenko (Astrophysical Inst., Academy of Sciences, Tadzhik SSR). Geomagnetism Aeronomy, 4: 146-9(1964).

A study was made, based on visual observations of auroras at Tixie Bay in 1961-3. Data are correlated with previous results for 1957-9. For the four 1-year periods of observations, the total number of occurrences, frequency of occurrence, mean brightness, mean height, and mean area of sunspots are given. A study was also made of the relative arrangement of different auroral forms in a latitudinal direction; mean height for different forms was determined. (M.J.T.)

12401 DYNAMICS OF THE EARTH'S RADIATION BELTS. I. THE SOURCES OF FAST PARTICLES. B. A. Tverskoi (Moscow State Univ.). Geomagnetism Aeronomy, 4: 174-80(1964). Translated from Geomagnetizm i Aeronomiya, 4: 224-32(1964).

Consideration is given to the sources of the fast particles of radiation belts. It is demonstrated that capture of particles from interplanetary space into closed drift orbits occurs during magnetic storms. The possibility of injection of particles to great altitudes as they are accelerated in the ionosphere is investigated, and it is established that this mechanism cannot account for the observed nature of variation in intensity with altitude. (auth)

12402 KINETIC INSTABILITY OF THE EARTH'S OUTER RADIATION BELT. A. A. Andronov and V. Yu. Trakhtengerts (Gor'kii State Univ., USSR). Geomagnetism Aeronomy, 4: 181-8(1964). Translated from Geomagnetizm i Aeronomiya, 4: 233-42(1964).

A nonlinear theory of the instability of the earth's outer radiation belt is developed on the basis of quasilinear equations. The value and the time dependence of the particle flux (electron current) leaving the belt, and the intensity of the ultra-low-frequency noise are determined. (auth)

12403 APPEARANCE OF A DAYTIME E LAYER AND ABSORPTION IN THE D LAYER OF THE IONOSPHERE AS THE SUN RISES. G. Nestorov and D. Samardzhiev (Geophysical Inst., Academy of Sciences, Bulgaria). Geomagnetism Aeronomy, 4: 235-8(1964). Translated from Geomagnetizm i Aeronomiya, 4: 301-6(1964).

A method is suggested for determining the time of appearance of the daytime E layer of the ionosphere and the height at which absorption commences in the D layer as the sun rises. Analysis results are given covering a 2-year period of measurements along a path at a frequency of 2.5 megacycles. Electron density in the E layer reaches values of $8-10 \times 10^3$ cm^{-3} when the sun's altitude is between −1 and +3°. The altitude range of the commencement of absorption in the D layer is dependent on season and varies between 70 and 80 km. (auth)

12404 COMPUTER CALCULATION OF NZ PROFILES OF THE IONOSPHERE WITH ALLOWANCE FOR BOTH COMPONENTS OF A MAGNETOSPLIT SIGNAL. N. P. Danilkin and S. A. Zhuchenko (Rostov-on-Don State Univ., USSR). Geomagnetism Aeronomy, 4: 239-43(1964). Translated from Geomagnetizm i Aeronomiya, 4: 307-12 (1964).

A description is given of the method and a logical program flow chart for computing the true altitude distribution of electron density on a computer with allowance for ordinary and extraordinary rays. The calculation formulas used to calculate the group index of refraction of an extraordinary ray are given. (auth)

12405 ALTERATION OF PARTICLE ENERGY IN A DIPOLE FIELD IN TRANSITIONS BETWEEN DIFFERENT DRIFT SURFACES. Yu. S. Krymov and B. A. Tverskoi (Moscow State Univ.). Geomagnetism Aeronomy, 4: 309-11(1964). Translated from Geomagnetizm i Aeronomiya, 4: 397-8(1964).

Processes associated with transitions of fast particles from one drift surface to another during magnetic storms are considered. These transitions are due to the drift of charged particles in the non-stationary electromagnetic field that develops when the earth comes into collision with a corpuscular stream. At the conclusion of a magnetic storm, when the field returns to its initial value, particles may, as a result of this process, either move away from the earth or approach it. The change of particle energy and the pitch angle at the equator are determined for this case. (C.E.S.)

12406 CYCLIC VARIATIONS OF ABNORMAL IONIZATION OF THE F2 LAYER. L. A. Yudovich (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 320(1964). Translated from Geomagnetizm i Aeronomiya, 4: 408(1964).

Variations of the time of appearance of the maximum values of f_0F2_s and the values of f_0F2_s in the course of the solar activity cycle are considered. Use was made of daily variations of f_0F2_s for 1957 to 1961 at stations located in the circumpolar region, within the auroral zone, and to the south of the zone. The period considered covers years of maximum solar activity and its decline. (C.E.S.)

12407 ONE THEORY OF THE FORMATION OF E_S IN MIDDLE LATITUDES. O. Ovezgel'dev and E. K. Vasil'eva. Geomagnetism Aeronomy, 4: 321-2(1964). Translated from Geomagnetizm i Aeronomiya, 4: 409-10(1964).

A detailed analysis of the nature of the dependence on the H-component of the magnetic field of the probable appearance of E_s was made. Data from 23 middle latitude stations in the northern hemisphere were used. Calculations were made of the probability of appearance of a sporadic layer in general (PE_s), the probability of an appearance with a limiting frequency of more than 5 and more than 7 for each hour of the day and night and for the day as a whole for all of these stations. The results indicate that the linear dependence of PE_s on the H-component of the magnetic field occurs only during the day and only for $PE_s > 5$ megacycles. (C.E.S.)

12408 THE SPORADIC E-LAYER OF THE IONOSPHERE AND DAILY VARIATIONS OF THE EARTH'S MAGNETIC FIELD. O. Ovezgel'dev and L. P. Korsunova. Geomagnetism Aeronomy, 4: 322-4(1964). Translated from Geomagnetizm i Aeronomiya, 4: 411(1964).

In accordance with existing views the daily variations of elements of the magnetic field are due to an electric current in the E region of the ionosphere, which produces movement of the conducting gas perpendicular to the geomagnetic field. Consequently, if the appearance of E_s is related to the development of an interlayer of increased ionization in the E region, it is to be expected that there will be a connection between E_s and daily variations of the magnetic field. This connection was investigated. The results obtained, however, justify the provisional conclusions that the appearance of an intensive E_s layer at any time of the day or night does not in the main exert a significant effect on daily variations of the geomagnetic field. (C.E.S.)

12409 X-RAYS IN THE AURORAL ZONES. A. I. Ershkovich. Geomagnetism Aeronomy, 4: 324-5(1964). Translated from Geomagnetizm i Aeronomiya, 4: 412(1964).

It is shown that measurements of the intensity of the x radiation which develops in the auroral zones of the planet may be used to estimate its magnetic moment. Detection of radiation with an energy of ~10 to 100 kev emitted by the

planet will indicate that it possesses a magnetic moment sufficient for the development of auroras. If the spatial distribution of the intensity of this radiation is known, it is possible to estimate the latitude on which the auroral zone of the planet lies. (C.E.S.)

12410 THE FORMATION OF THE SPORADIC-E LAYER. R. B. Hall (Brunel Coll., London). J. Atmospheric Terrest. Phys., 26: 1143-6(Dec. 1964).

It is assumed that sporadic-E is caused by the vertical movement of ionization to form a layer of enhanced ionization, the limiting width of such a layer being determined by the effects of diffusion. Thus since the diffusion constant varies markedly with geomagnetic latitude it is predicted that layer formation will be more likely near to the geomagnetic equator and that the layer thickness will vary as sin I, where I is the angle of magnetic dip. (auth)

12411 THE LATITUDINAL SHIFT OF THE AURORAL BELT. S.-I. Akasofu (Univ. of Alaska, College). J. Atmospheric Terrest. Phys., 26: 1167-74(Dec. 1964).

The term auroral belt is proposed to signify the region which is occupied by the aurora at a particular instant. It is shown that the center line of the auroral belt moves greatly with respect to its average location (namely the auroral zone), depending on the degree of the magnetic activity. When the magnetic activity is very low ($\Sigma K_p < 10$) for 24 hours or more, the center line of the auroral belt in the midnight sector shifts to geomag. lat. as high as 75°. A moderate magnetic activity ($\Sigma K_p = 20 \sim 30$) places the center line of the belt in the vicinity of the auroral zone in the midnight sector. For a short period (of the order 30 min) during great magnetic storms, the belt can be located along geomag. lat. as low as 50°. (auth)

12412 ANALYSING THE F-REGION WITH OVERLAYS. G. A. M. King and M. D. Lawden (Dept. of Scientific and Industrial Research, New Zealand). J. Atmospheric Terrest. Phys., 26: 1273-80(Dec. 1964).

The theory of electron production and recombination in the F-region was applied to the preparation of model $h'(f)$ curves. These curves, used as overlays, enable ionograms to be analyzed rapidly for measures of electron production and the linear recombination coefficient and for the scale height of atomic oxygen. (auth)

12413 SUDDEN ENHANCEMENT OF ATMOSPHERICS DUE TO HIGH-ALTITUDE NUCLEAR EXPLOSIONS. A. K. Sen (Univ. of Calcutta). J. Atmospheric Terrest. Phys., 26: 1291-4(Dec. 1964).

Artificial disturbances in the upper atmosphere produced by high-altitude nuclear detonations are discussed. The results of an analysis of sudden enhancement of atmospherics at 30, 120, and 210 kc following the Russian megaton-range high-altitude nuclear detonations are presented. The rise-time, duration, and amplitude of the disturbances were measured. (C.E.S.)

12414 SIMULTANEOUS CURRENT PATTERNS OF POLAR MAGNETIC STORMS (D_p-FIELD) IN THE NORTHERN AND SOUTHERN POLAR REGIONS DURING IGY. Takesi Nagata and T. Iijima (Tokyo Univ.). J. Geomagnet. Geoelec., 16: 210-20(1964).

The average patterns of equivalent ionospheric current system of polar magnetic storms (D_p-field) for both northern and southern polar regions are constructed by analyzing exactly simultaneous data in both polar regions during the IGY period. Those data of magnetic storms are classified into two groups; i.e., severe storm for which $\overline{K}_p = 7.2$ and moderate storm for which $\overline{K}_p = 4.3$. In both cases, the D_p patterns for the northern and southern polar regions are almost exactly symmetric with each other with respect to the geomagnetic coordinates, suggesting that the geomagnetic conjugacy well holds between the two polar regions. Several remarks are made on the mechanism of causation of the D_p field. It is emphasized, in particular, that the larger part of polar cap currents of the D_p field may be attributable to an enhancement of the S_q^p field by a stronger solar wind. (auth)

12415 THE ATMOSPHERIC PRESSURE WAVE GENERATED BY A NUCLEAR EXPLOSION. PART 2. D. B. van Hulsteyn (Univ. of Michigan, Ann Arbor). J. Geophys. Res., 70: 271-8(Jan. 15, 1965).

The Green's function makes it possible to determine the time-dependent pressure function at the observer's position in terms of the pressure generated by a nuclear explosion. It is convenient to treat the blast by using a surface, rather than a point source representation. This configuration permits the determination of the relation between the energy of the explosion and the amplitude of the theoretical pressure pulse. The final step involves the performing of an inverse transformation to determine the time variation of the pressure wave train. (auth)

12416 LONG-PERIOD PULSATIONS OF AURORAL-ZONE X-RAYS. H. Trefall and S. L. Ullaland (Univ. of Bergen). Nature, 204: 1148-50(Dec. 19, 1964).

During a series of balloon flights from northern Norway, observations of nearly periodic bremsstrahlung x ray intensity variations were made. These observations are reported and discussed in relation to other observations of long-period geomagnetic pulsations. Current thinking concerning the magnetic régime in the Earth's immediate neighborhood is also discussed in relation to the bremsstrahlung x ray variations. (J.R.D.)

12417 WORLD-WIDE PROPAGATION OF IMPULSIVE MICROPULSATION ACTIVITY THROUGH THE IONOSPHERE. J. A. Jacobs, G. Rostoker, and T. Watanabe (Univ. of British Columbia, Vancouver). Nature, 205: 61-2 (Jan. 2, 1965).

The method by which impulsive Pi 2 micropulsations spread over the earth is discussed. The origin of Pi 2 micropulsations is discussed briefly. According to the theory of electromagnetic induction, a periodic magnetic disturbance in a conducting material propagates with phase velocity $T^{1/2}/\sqrt{\sigma}$, where Ti is the period (sec) of the disturbance and σ is the specific conductivity (E.M.U.). If $\sigma = 5 \times 10^{18}$ is taken as the daily mean in the E region and T = 100, the phase velocity is about 40 km/sec, which agrees with results obtained by others. The calculation is a crude order of magnitude estimate for the one-dimensional case assuming an isotropic medium. However, the results are consistent with the experimental evidence, and seem to indicate a strong possibility that the described mode of propagation for Pi 2 micropulsation is correct. (P.C.H.)

12418 THE INFLUENCE OF THE EARTH'S ATMOSPHERE ON GEOMAGNETICALLY TRAPPED PARTICLES. Martin Walt (Lockheed Missiles and Space Co., Palo Alto, Calif.) and William M. MacDonald. Rev. Geophys., 2: 543-77(Nov. 1964).

The motion of energetic, charged particles trapped in the geomagnetic field is reviewed, and the methods of calculating the effect of the ambient atmosphere on trapped electrons and protons are presented. The results of these theoretical considerations are compared with the available experimental data to determine the spatial regions where collisions of the trapped particles with atmospheric constituents govern the long-term behavior of the particles. It is concluded that during periods of minimum solar activity atmospheric collisions are the most important loss mechanism for electrons in the region $L \gtrsim 1.25$, where L is McIlwain's magnetic shell parameter. Above this region the behavior of electrons is controlled by other, at present unknown, forces. For protons, it appears that the atmosphere controls the loss rate for the spatial region $L \gtrsim 1.4$, although the evidence for this conclusion must be considered tentative at present. (auth)

12419 THE GEOMAGNETIC EFFECTS OF MAJOR FLARES IN THE SUNSPOT REGIONS OF MAGNETIC CLASSES γ AND $\beta\gamma$. Chuan-sin Liu. Ti Ch'iu Wu Li Hsueh Pao, 13: 11-19(1964). (In Chinese)

The geomagnetic effects of solar flares of importance 3 and 3^+ in the sunspot regions of magnetic classes γ and β during 1938–1958 are examined statistically according to the declination of the sun, the position angle of the sun's

axis of rotation from the north point of the disk, and the heliographic coordinates of the flare. Results of correlation and regression analysis are drawn on the heliographic chart as isolines of geomagnetic disturbance. The data of the solar wind velocity, measured by the spectrometer on the spacecraft Mariner II, are correlated with the corresponding geomagnetic A, index; the indices are used with the isomagnetic chart to estimate the distribution of the radial velocity of solar wind along the earth's orbit after the relevant eruptions. (auth)

12420 VARIATION OF THE STRUCTURE IN THE OUTER RADIATION BELT DURING THE MAIN PHASE OF A MAGNETIC STORM. C. Y. Pu and W. I. Li (Peking Univ.). Ti Ch'iu Wu Li Hsueh Pao 13: 91-105(1964). (In Chinese).

Some variations of the structure in the outer radiation belt during the main phase of a magnetic storm are discussed, using two adiabatic invariants of relativistic charged particles. It is assumed that the main phase is caused by the ring current of the storm belt situated outside the center of the radiation belt and consisting of solar plasma penetrating into magnetosphere. The calculation was carried out for electrons with initial energy 20 kev and 1 Mev. It is shown that during the main phase of a magnetic storm the electrons drift outward and the pitch angles are decreased, but the height of the mirror points is increased. Thus auroral excitation during the main phase can not be attributed to the precipitation of electrons into the atmosphere by the slow change of geomagnetic field. It is also shown that the variation of counting rate during the main phase is produced primarily by the decrease of electron density accompanying the expansion of the tubes of force and by electron deceleration. Changes in the distribution of electron fluxes along the lines of force could be explained in terms of the deceleration related to the pitch angles. The results obtained agree fairly well with observations by Explorer VI. (auth)

12421 THE VARIATION OF THE OUTER RADIATION BELT DURING THE MAGNETIC STORM. Chen-hsing Liu (Academy of Sciences, Peking) and C. Y. Pu. Ti Ch'iu Wu Li Hsueh Pao, 13: 191-200(Sept. 1964). (In Chinese)

The effect of larger geomagnetic fluctuations on the distribution of charged particles trapped in the outer radiation belt is investigated. It is found that, during the main phase, the position of maximum electron intensity shifts outward with decreasing peak intensity, the kinetic energy distribution peak shifts toward lower energy, the pitch angles decrease, and the mirror point altitudes increase. In the sudden commencement, the electron intensity peak moves inward with increasing intensity, the kinetic energy peak shifts to higher energies, the pitch angles increase, and the mirror point altitudes decrease. The density and thus the intensity of charged particles on the magnetic equator is reduced during the main phase, because of the expanding tube of force and the diminishing kinetic energy. In the initial phase, owing to the descent of the mirror point, some of the charged particles precipitate into the lower atmosphere and excite aurorae; the charged particle intensity on the magnetic equator still tends to increase, due to the compression of the tube of force and the increase of the particle kinetic energy. (auth)

12422 THE MECHANISM OF PENETRATION OF SOLAR PLASMA INTO THE GEOMAGNETIC FIELD. PART I. Heng Du (Peking Univ.) and Jeou-jang Jaw. Ti Ch'iu Wu Li Hsueh Pao, 13: 201-10(Sept. 1964). (In Chinese)

Since Singer explained the main phase ring current by charged particles trapped in the geomagnetic field, the origin of these particles became one of the important problems of main phase theory. A mechanism is suggested through which the process of penetration of the solar wind into the magnetosphere can be traced. If there is no other force than magnetic field, all charged particles approaching the magnetosphere are reflected into space even around the neutral points on the boundary. However, because of the difference in reflection of electrons and protons, a polarized electrical field is established around the neutral point in a westward direction. Under the action of this electrical field, charged particles of small pitch angles will pass through the neutral point. From numerical integration by computer, it is concluded that electrons are captured with larger probability than protons. With a suitable choice of the solar wind parameter and capture probability, results explain fairly well the theoretical investigation of Parker and others. (auth)

12423 LONGITUDINAL ASYMMETRY OF THE MAIN PHASE OF THE GEOMAGNETIC STORM. Heng Du (Peking Univ.). Ti Ch'iu Wu Li Hsueh Pao, 13: 211-15(Sept. 1964). (In Chinese)

By the mechanism of drift motion of polarized electric field, the electrons of the solar wind penetrate into the magnetosphere through the neutral point. These electrons trapped in the geomagnetic field drift eastward. Before the electrons from a closed cycle around the earth, the distribution of electrons and consequently the current and magnetic field recorded at the earth's surface in the equatorial region are asymmetrical with respect to local time. The variation of magnetic field was calculated as a function of storm time. The period of electron drift around the earth was assumed to be two days. Theoretical results coincide fairly well with statistical curves obtained from the long series data from Zo-Se and Huancayo Observatories. (auth)

12424 ON THE PROPAGATION OF ELECTROMAGNETIC WAVES IN A HOMOGENEOUS GYROTROPIC MEDIUM. I. A. Biryulin. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 4, 29-33(July-Aug. 1964). (In Russian)

Electromagnetic wave propagation in homogeneous gyrotropic ionospheric media was studied using an invariant method. A dispersion ionospheric formula was derived on the basis of this method. (tr-auth)

12425 ON THE THEORY OF THE HYDROMAGNETIC DYNAMO. S. I. Braginskii. Zh. Eksperim. i Teor. Fiz., 47: 2178-93(Dec. 1964). (In Russian)

The generation equations are extended to the nonstationary case and are solved for a simple model of a hydromagnetic dynamo in the form of an infinite plane liquid layer. It is suggested that in a highly conducting liquid auto-stabilization of the tangential discontinuity may be possible as a result of the dynamo effect. The generation equations are applied in an analysis of the hydromagnetic dynamo of the Earth. (auth)

12426 WHISTLERS AND RELATED IONOSPHERIC PHENOMENA. Robert A. Helliwell. Stanford, Calif., Stanford University Press, 1965. 355p. $12.50.

A first-order theory of whistlers is presented, including the calculation of the intensity of whistler-mode signals. The characteristics and classifications of whistlers are described. Fixed-frequency whistler-mode experiments are discussed, together with electron density measurements in the magnetosphere using whistlers. The characteristics of vlf emissions (ionospheric noise) are reviewed; spectra for various types of emissions are included. Theories for ionospheric noise are outlined. 470 references. (D.C.W.)

12427 MOTION OF CHARGED PARTICLES IN THE EARTH'S MAGNETIC FIELD. Joseph W. Chamberlain. Documents on Modern Physics. New York, Gordon and Breach Science Publishers, 1964. 39p. $3.95 (cloth); $1.95 (paper).

Theory for the motion of a charged particle in a dipole magnetic field is outlined, together with the guiding-center theory of particle orbits and the hydromagnetic theory of drift motion. (D.C.W.)

Low Temperature Physics

Refer also to abstracts 11940, 11941, and 12074.

12428 (NBS-8481) CRYOGENIC ALUMINUM ELECTROMAGNET. Final Report. Jesse Hord (National Bu-

reau of Standards. Boulder Labs., Boulder, Colo.). Nov. 2, 1964. Project SHERWOOD. 104p. Dep.(mn); $4.00(cy), 2(mn) OTS.

A liquid H_2 cooled, tape-wound, high-purity Al electromagnet was built and tested to 95 kilogauss with a total power consumption of 31 kilowatts. Technology concerning the design, fabrication, and testing of low-power, high-field cryogen-cooled electromagnets is presented. The maximum field attainable with an electromagnet is limited by the mechanical strength of the coil. The field strength obtained with a given coolant system and magnet power supply may also be limited by the heat transfer efficiency and heat capacity of the coolant and the resistivity of the conductor. Therefore, stresses, heat transfer, and conductor resistivity must be simultaneously considered to obtain an optimum coil design. Results of investigations concerning these field-limiting parameters are reported. (auth)

12429 (NP-14641) ON SUPERCONDUCTIVITY OF THE COHEN-FALICOV MODEL. Sadao Nakajima (Tokyo Univ. Inst. for Solid State Physics). Sept. 1964. 17p. Dep.(mn).

It is shown that a certain model represents a gapless superconductor. The analysis is made in the weak coupling limit. The specific heat is nearly linear and the thermodynamic critical field is nearly quadratic in temperature. The model shows neither non-linear nor Josephson tunneling. The coefficient b in the model's gap parameter $\Delta(\epsilon) = b\epsilon$ obeys Ginzburg-Landau equations, so that the model does show the Meissner effect and infinite d-c conductivity. The shift of the transition point caused by non-magnetic impurities is also obtained to first order of the impurity concentration. (auth)

12430 (NP-14644) ON ELECTRON TUNNELING FROM A HARD SUPERCONDUCTOR IN THE MIXED STATE. Sadao Nakajima (Tokyo Univ. Inst. for Solid State Physics) and Yuri Nakao (Tokyo Univ.). Oct. 1964. 28p. Dep.(mn).

A derivation of the Ginzburg-Landau equation from BCS theory is reformulated in such a form that one can apply it to dynamical processes involving quasiparticle excitations. As the simplest example, the method is applied to electron tunneling from an intrinsic hard superconductor in a mixed state. It is shown that near the transition point one obtains the tunneling current simply averaged over the distribution of energy gap. Some numerical estimates are made of the dependence of I–V characteristics on magnetic field in the case of Nb. (auth)

12431 TEMPERATURE DEPENDENCE OF THE SUPERCONDUCTING ENERGY GAP OF THALLIUM FILMS DETERMINED BY ELECTRON TUNNELING. J. C. Neel, A. Ballonoff, and G. J. Santos, Jr. (Fairchild Semiconductor-Research and Development Lab., Palo Alto, Calif.). Appl. Phys. Letters, 6: 2-3(Jan. 1, 1965).

The superconducting energy gap of evaporated thallium films was measured down to 0.804°K by the electron tunneling technique. The reduced energy gap of thallium as a function of the reduced temperature shows good agreement with the BCS theory. (H.D.R.)

12432 SUPERCONDUCTING dc GENERATORS AND MOTORS. David L. Atherton. IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 1: 67-71(Dec. 1964).

The simple theory of superconducting d-c generator operation is presented, and the loss mechanisms are examined. Possible practical applications for superconducting d-c motors and generators are discussed. (H.D.R.)

12433 EDGE-EFFECT LIMITATIONS ON THE CRITICAL CURRENTS OF THIN FILMS OF TIN. F. B. Hagedorn (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 36: 352-5(Feb. 1965).

The edges of planar thin-film strips of tin are shown to limit the supercurrent carrying capacity of the films in some cases. This edge effect is demonstrated by means of a special structure which provides two current flow-paths through the same film. The film strip edges are included in only one of these two paths. Detailed results are given for a 4400-Å film of tin in which d-c critical currents near the Silsbee limit are observed when the edges are excluded. Including the edges reduces the critical current for this film by more than 30%. It is suggested that an evaporation process can probably be developed which leads to films which will not exhibit this edge effect. The special structure would provide a useful tool for this process development, and it can also be adapted to serve as an improved gate for thin-film cryotrons. (auth)

12434 CRITICAL FIELD MEASUREMENTS OF SUPERCONDUCTING NIOBIUM NITRIDE. T. H. Courtney, J. Reintjes, and J. Wulff (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 660-1(Feb. 1965).

The superconducting transition of a nitrided niobium sample prestressed at 42,500 psi and heat treated in flowing nitrogen was investigated. A plot of the transition as a function of field and temperature is shown. (C.E.S.)

12435 REGULAR MODELS FOR SOLID HYDROGEN. [PART] III. G. M. Bell (Chelsea Coll. of Science and Tech., Eng.) and W. M. Fairbairn. Mol. Phys., 8: 497-503(Dec. 1964).

A regular model for a hexagonal close-packed lattice of ortho-hydrogen molecules is treated by a first-order statistical approximation. With nearest-neighbor pair energies due mainly to the quadrupole–quadrupole interaction the model is unsymmetric and anisotropic but spatial ordering based on alternate layer sub-lattices occurs at low temperatures. To obtain correct ratios for the numbers of nearest-neighbor site links at different orientations to the crystal axis an octahedron of six sites is used as the basic group in the first-order approximation. It is found that a second-order transition to the layer sub-lattice distribution occurs at T = 3.99°K. (auth)

12436 SUPERCONDUCTING MAGNET COILS FOR THERMONUCLEAR RESEARCH. W. F. Gauster* and D. C. Freeman, Jr. (*Oak Ridge National Lab., Tenn.). Nucl. Fusion, 4: 185-92(Sept. 1964).

The present state of development of high-field superconductivity is reviewed with particular regard to the prospective use of that phenomenon in magnet coils for thermonuclear research. It is concluded that although magnets for thermonuclear research are not yet practical, their development is advancing rapidly to the stage of feasibility for that purpose. Progress at present is dependent upon the achievement of a greater understanding of the basic and applied science of superconductivity and the development of materials less susceptible to a phenomenon known as flux jumping. A review of the present state of scientific knowledge pertinent to large-magnet technology is provided. (auth)

12437 SUPERCONDUCTING TUNNELING INDUCED BY GIGACYCLE SOUND WAVES. Y. Goldstein and B. Abeles (RCA Labs., Princeton, N. J.). Phys. Letters, 14: 78-9 (Jan. 15, 1965).

The effect of microwave phonons on the tunneling characteristics of Al–Pb superconducting tunnel diodes was investigated. A variable d-c voltage bias was applied to the tunnel diode and the change in the tunneling current due to the microwave pulses was detected by a low noise pulse amplifier. An oscillogram trace of the tunnel diode current pulses showed the amplitudes to be strongly dependent on the d-c bias voltage, resembling closely the second derivative of the I–V characteristic. (L.B.S.)

12438 THE PRESSURE DEPENDENCE OF TRANSITION TEMPERATURE IN SOME SUPERCONDUCTORS. B. N. Ganguly and K. P. Sinha (National Chemical Lab., Poona, India). Phys. Letters, 14: 85-7(Jan. 15, 1965).

A possible mechanism of the pressure dependence of the transition temperature in superconductors having two bands, s-p or s-d, is discussed, using a perturbation treatment for interband scattering of the electrons near the Fermi surface. The Bogoliubov and a canonical transformation are applied to the hamiltonian for the system, and energy gap relations are derived. A theoretical curve along with ex-

perimental points for In, Sn, and Nb_3Sn systems, which involve overlapping s and d bands, is presented. (L.B.S.)

12439 DENSITY OF STATES OF A SUPERCONDUCTOR WITH PARAMAGNETIC IMPURITIES IN A MAGNETIC FIELD. K. H. Bennemann (Univ. of Illinois, Urbana and Technische Hochschule, Karlsruhe). Phys. Letters, 14: 92-3(Jan. 15, 1965).

The effect of paramagnetic impurities on the smearing of the density of states arising from the anisotropy caused by the magnetic field is studied; and the relation between the impurity concentration for which the energy gap becomes zero and for which superconductivity ceases is determined. (L.B.S.)

12440 FLUX QUANTIZATION NOISE ON HOLLOW SUPERCONDUCTING CYLINDERS. D. J. Van Ooijen (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 14: 95-7(Jan. 15, 1965).

The mean square voltage noise, arising from quantized flux inleak into a hollow superconducting cylinder consisting of a thin layer of tin evaporated onto a glass rod, was measured as a function of temperature. The value of the flux quantum calculated from the measurements agrees with the theoretical value $\Phi_0 = \hbar c/2e$. (L.B.S.)

12441 ANNIHILATION INSTABILITY IN HARD SUPERCONDUCTORS. M. R. Beasley, W. A. Fietz, R. W. Rollins, J. Silcox, and W. W. Webb (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 137: A1205-8(Feb. 15, 1965).

Mutual annihilation between neighboring fluxoids of opposite flux direction is proposed as an origin for some instabilities in hard superconductors. The presence of a reversal of the direction of magnetic induction within the superconductor is recognized as a necessary condition for the annihilation instability, and the boundaries of the region of instability can be calculated from critical-state concepts. Specimens of cold-worked niobium-zirconium alloys were found to display a region of instabilities with boundaries and characteristics expected of the annihilation instability. (auth)

12442 BEHAVIOR OF DIRTY SUPERCONDUCTORS IN HIGH MAGNETIC FIELDS. P. G. de Gennes (Faculté des Sciences, Orsay, France). Physik Kondensierten Materie, 3: 79-90(Dec. 11, 1964).

Some properties of homogeneous, dirty superconductors are discussed for the case where the motion of electrons in the normal state can be described as a diffusion process. It is shown that at the nucleation field (H_{c2} or H_{c3}) corresponding to the onset of superconductivity, the order parameter $\Delta(r)$ satisfies a linearized equation which has the Landau-Ginsburg form at all temperatures. This demonstration considerably extends the validity of the existing calculations of H_{c2} and H_{c3}; it is possible to show in particular that the ratio H_{c3}/H_{c2} and the form of the angular dependence of H_{c3} are independent of temperature. It is also possible to compute explicitly the local density of states $N(r,\omega)$, at any point r and energy ω, for fields slightly below H_{c2}(or H_{c3}), when the order parameter is strongly r-dependent. Due to some remarkable sum rule properties, $N(r,\omega)$ depends only on the local value of the order parameter $\Delta(r)$. These results may be of use in the interpretation of tunneling experiments in the mixed state and of surface superconductivity. (auth)

12443 SUPERCONDUCTIVITY AT ROOM TEMPERATURE. W. A. Little. Sci. Am., 212: 21-7(Feb. 1965).

It is shown that theoretical studies suggest that it is possible to synthesize organic materials that, like certain metals at low temperatures, conduct electricity without resistance at room temperatures. The mechanism by which the superconducting current might be transmitted by such a molecule is described, and the mechanisms by which an electric current is transmitted in an ordinary conductor and in a metallic superconductor are reviewed. (C.E.S.)

12444 QUANTIZED MAGNETIC FLUX IN SUPERCONDUCTORS. R. D. Parks (Univ. of Rochester, N. Y.). Science, 146: 1429-35(Dec. 11, 1964).

Experiments confirming the concept of superconductivity as a macroscopic quantum phenomenon are reviewed. The discovery of quantized flux, quantum periodicity in T_c, Josephson tunneling, and the vector potential are discussed. A bibliography of 27 references is included. (C.E.S.)

12445 DERIVATION OF GENERALIZED GINZBURG-LANDAU EQUATION FOR PURE SUPERCONDUCTOR FROM A VARIATION PRINCIPLE. Gert Eilenberger (Universität, Göttingen, Ger.). Z. Physik, 182: 427-38 (1965). (In German)

It is shown that generalized Ginzburg-Landau equations follow from the expression $\Omega = \mathrm{Sp}\,\rho(H + T\ln\rho) + 1/2\mu_0\int (B - B_a)^2 d^3r$ for the thermodynamic potential if the BCS-hamiltonian is used for H and if $\ln\rho$ is a certain operator which contains only the functions $\Delta(r)$ and A(r) besides quadratic expressions of Ψ and Ψ^+. When self-energy expressions are suppressed, the stationarity condition for Ω is exactly equivalent to the well known Gorkov equations. The Ω is expressed in terms of a thermodynamic Greens function which is then calculated by an elementary but gauge invariant method of solving the Gorkov equations approximately. The second approximation leads directly to the thermodynamic potential which Werthamer derived from his generalized Ginzburg-Landau equations. (auth)

12446 ON MOTION OF CHARGES IN SOLID HELIUM. A. I. Shalnikov (Inst. of Problems in Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1727-32 (Nov. 1964). (In Russian)

The temperature dependence of a current (produced by a β source) in helium crystals grown at pressures between 25.3 and 154 atm is measured. It is found that the nature of the motion of electric charges in liquid helium (He I and He II) and in helium crystals is not the same.

12447 EXPERIMENTAL OBSERVATION OF TUNNELING OF COOPER PAIRS BETWEEN THIN LAYERS OF SUPERCONDUCTING TIN. I. K. Yanson, V. M. Svistunov, and I. M. Dmitrenko (Inst. of Low Temperature Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i. Teor. Fiz., 47: 2091-4(Dec. 1964). (In Russian)

Features of the volt-ampere curves of $Sn-SnO_2-Sn$ tunnel structures due to tunneling of the superconducting electron pairs and many-particle tunneling are experimentally investigated in the 1.5–4.2°K temperature range. The dependence of the superconducting current on temperature and magnetic field is investigated. (auth)

12348 A CRITERION OF SUPERCONDUCTIVITY. I. O. Kulik (Inst. of Low Temperature Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 2159-67(Dec. 1964). (In Russian)

Interaction between electrons in a metal due to virtual phonon exchange as well as to longitudinal electromagnetic oscillations (Coulomb interaction) is considered and the influence of Coulomb effects on the phonon spectrum is taken into account. A superconductivity criterion is obtained which has the form (for the isotropic model) $\rho s^2 < \frac{1}{3}Nmv_F^2$, where ρ is the metal density, s the velocity of longitudinal sound, N the electron density, m electron mass and v_F the Fermi velocity. The criterion is compared with the experimental data. (auth)

12449 THERMAL CONDUCTIVITY OF THE INTERMEDIATE STATE OF SUPERCONDUCTORS. [PART] II. A. F. Andreev (Inst. of Problems in Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 2222-8 (Dec. 1964). (In Russian)

The thermal conductivity coefficient of the lamellar and thread-like structures of the intermediate state is calculated for heat transfer along phase interfaces when the electron mean free path considerably exceeds the characteristic size of the normal regions α. An arbitrary electron dispersion law is assumed. The thermal conductivity coefficient for a lamellar structure is independent of the electron mean free path l; the coefficient for a thread-like structure decreases with increase of l as $\ln(l/\alpha)/l$. (auth)

12450 SCATTERING OF NEUTRONS BY QUANTIZED MAGNETIC FLUX LINES IN SUPERCONDUCTORS OF THE

SECOND GROUP. M. P. Kemoklidze (Inst. of Problems in Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 2247-50(Dec. 1964). (In Russian)

Diffraction of neutrons on quantized magnetic flux lines in superconductors of the II group is considered. The formulas derived can be employed for determining the magnetic structure of a superconductor on the basis of neutron diffraction data. (auth)

12451 IONS IN He II IN A MAGNETIC FIELD. Lothar Meyer (Univ. of Chicago). 11p. (CONF-651-18)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The effect of a transverse magnetic field on ions produced by ^{210}Po alpha particles in He II was measured. The apparent ion mobility as a function of electric field at 0.415°K indicated that the Hall mobility is identical with the previously obtained d-c mobility. Vortex rings with one quantum of circulation were observed to be created by the ions at high fields. The distance of closest approach of a vortex ring to a wall and the possibility that the charge captured by the vortex ring can tunnel to the collector electrodes are examined. (H.D.R.)

12452 VORTEX LINES IN SUPERCONDUCTORS. P. G. de Gennes (Faculte des Sciences, Orsay, France). 16p. (CONF-651-15)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Theoretical work is described on vortex line structure and behavior in superconductors. Expressions concerning singular line structure, interactions between lines, the line lattice representation, and elementary excitations in the Schubnikov phase are derived and discussed. (H.D.R.)

12453 SUPERCONDUCTING MAGNETS. Z. J. J. Stekly (Avco Research Lab., Everett, Mass.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/PID-3, 12p. $1.00. (CONF-763-7).

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A brief review of the properties of superconductors and their behavior in coils, as well as a short general discussion of the economics of superconducting magnets is presented. (P.C.H.)

Neutron Physics

Refer also to abstract 11769.

12454 (EUR-1637.f) PROPAGATION DES NEUTRONS DANS DES MASSIFS D'URANIUM NATUREL ET D'URANIUM NATUREL-ACIER. (Comparison of the Propagation of Neutrons in a Natural Uranium Block and in One Composite Steel and Natural Uranium Block). C. Beets, J. L. Campan, P. Caumette, P. Colle, H. Deckers, A. Desprets, and C. P. Zaleski (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Cadarache). 1964. 34p. (CONF-133-41). Dep.(mn).

From International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963.

A study has been made of the propagation of neutrons in a natural uranium block 40 cm thick, and in a block of steel 100 cm thick, joined side by side to the uranium block. The open face of the uranium block is subjected to a flux of thermal neutrons, which generates a flux of fast neutrons within a distance of a few centimeters. An attempt was made to measure the distribution in space and energy of this flux. The first step was to compare the results of the measurements with those obtained with an 80 cm thick uranium block. Then an attempt was made to obtain the spectra and fluxes by simple analysis of the experimental results, using various methods. At the same time theoretical studies were carried out. It was possible to analyze the validity of the different methods of calculation employed on the one hand, and of the neutronic constants used on the other. Finally, a description is given of a new exponential experiment designed to specify the essential parameters of the asymptotic spectrum in natural uranium, and to study the effects resulting from the introduction of small plates of various metals. The experimental program is described, together with comments on the results of the preliminary calculations and of the comparative calculations relative to the 40 and 80 cm blocks. (auth)

12455 (EUR-2174.i) SOLUZIONE NUMERICA DI ALCUNI PROBLEMI BIDIMENSIONALI DELLA DIFFUSIONE NEUTRONICA COL METODO VARIAZIONALE DI RITZ. (Numerical Solution of Some Two-Dimensional Diffusion Neutronical Problems by the Variational Ritz Method). I. Galligani (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy). 1964. 82p. Dep.(mn).

The approximate solutions of the homogeneous problem and of the inhomogeneous problem of the multigroup neutron diffusion theory may be obtained by searching for the functions which render suitable stationary functionals. These functions are calculated by the Ritz method. Some numerical experiments are given in order to compare the Ritz method with the finite difference method on two-dimensional diffusion problems. (auth)

12456 (GEAP-4731) TRANSPORT EQUIVALENT DIFFUSION THEORY. Quarterly Progress Report No. 2, July 1–September 30, 1964. G. H. Kear (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 9, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The spatial variation of the transport evaluated diffusion coefficient is discussed. Appropriate spatial averaging methods are possible which ensure conservation of reactivity as well as regional power. Techniques for achieving this from known transport results are being studied. (auth)

12457 (JINR-P-1903) RASSEYANIE KHOLODNYKH NEITRONOV NA VODE I NEKOTORYKH ORGANICHESKIKH VESHCHESTVAKH. (Scattering of Cold Neutrons in Water and in Some Organic Materials). V. V. Golikov, I. Zhukovskaya, F. L. Shapiro, A. Shkatula, and E. Yanik (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1964. 22p. Dep.(mn).

The spectra of quasielastic and inelastic scattering of cold neutrons in water, ethylene glycol, benzene, acetic acid, naphthalene, and dioxane have been measured by the time-of-flight method with a pulsed reactor. The results are presented. The measurements were made over a wide range of temperatures, including the melting point. Some features of quasielastic and inelastic scattering are discussed. It is pointed out, in particular, that the diffusion coefficient in liquid ethylene glycol calculated from the widening of the beryllium edge grows with temperature much slower than that calculated on the basis of the values of viscosity by the Stokes-Einstein formula. (auth)

12458 (JUL-179-RX) H_2O-STANDARD-PILE. G. Borchardt and B. Hasenclever (Kernforschungsanlage. Institut fur Reaktorexperimente, Julich). Sept. 1964. 14p. Dep.(mn).

In addition to the paraffin stack and the manganese bath, a water bath is also available as a neutron standard. The construction of such a water bath for use as a neutron standard was described. The water container, shielding calculations, Ra–Be neutron source, movable coordinate system, addition irradiation device for foils, the hollow body, the rotary disc, and the water purification are considered. (J.S.R.)

12459 (TID-21110) ITERATIVE METHODS FOR SOLUTION OF DIFFUSION PROBLEMS IN POLAR COORDINATES. D. B. MacMillan (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 3, 1964. Contract W-31-109-eng-52. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Three iteration methods for approximately computing steady-state solutions of the diffusion equation in a planar region comprising a circular sector are presented. The methods use a finite mesh based on the polar coordinate system. The methods are: successive azimuthal-line overrelaxation; successive radial-line overrelaxation; and alternating-direction implicit iteration. (T.F.H.)

12460 VACUUM BOUNDARY CONDITIONS FOR THE SPHERICAL HARMONICS METHOD. F. D. Federighi (Institut fur Reaktorforschung, Wurenlingen, Switzerland). Nukleonik, 6: 277-85(Oct. 1964).

The spherical harmonics method is used to obtain approximate solutions to the Boltzmann equation of neutron transport theory. In spite of this wide use, the boundary conditions to be applied at a vacuum boundary were never uniquely specified. A derivation of a unique set of consistent boundary conditions for both the flux and importance function in the P_n approximation is presented. This derivation is based on only the use of a spherical harmonics expansion and the principle of importance weighting (or the variational method). The boundary conditions so obtained are shown to give better values for the extrapolated endpoint than either of the more commonly used boundary conditions. The boundary conditions were tabulated numerically for direct use in most spherical harmonics calculations. (auth)

12461 NEUTRON ABSORPTION IN SPHERICAL AND CYLINDER-SHAPED PROBES. H. Buchholz and W. Schnabel (Hahn-Meitner-Institut fur Kernforschung, Berlin). Nukleonik, 6: 311-13(Oct. 1964). (In German)

A method is given for experimental determination of the absorption of thermal neutrons on probes of optional geometry with regard for correction factors for self-absorption and flux disturbance. For the special case of a spherical probe the correction factors agreed with those calculated using the assumptions of Wirtz. The method is of importance in radiation chemistry for dosimetry of energy-rich particle beams, which are produced in a system by absorption of thermal neutrons. (tr-auth)

12462 ON THE ÖZEMRE'S APPROACH TO THE PROBLEM OF REFLECTED MEDIA. Cetin Ertek (Dept. of Experimental Reactor Physics, Istanbul). Nukleonik, 6: 325-6(Oct. 1964). (In German)

It is shown that the global method proposed by Özemre for reflected media is based on a tacit assumption, which can not hold in general but which is a fair approximation. The comparison of this method with the two-group and the modified one-group theories suggested that it occupies a place between them. (auth)

12463 A GENERALIZED P-N APPROXIMATION FOR NEUTRON TRANSPORT PROBLEMS. G. C. Pomraning (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nukleonik, 6: 348-56(Nov. 1964).

A general approximation method for the neutron transport equation is presented. The basis of the method is to expand the angular dependence of the directional flux in a full set of spherical harmonics, but to allow a more general truncation procedure than is used in deriving the conventional spherical harmonic equations. This allows maximum use to be made of any qualitative ideas on the nature of the solution. As examples of the method, three specific approximations are considered. The first assumes that the directional flux is almost isotropic and is shown to be equivalent to the usual spherical harmonics method. The second assumes that the flux is very highly anisotropic and thus forms a complement to the usual spherical harmonic method. The third assumes that the flux is in its asymptotic distribution, and yields a set of equations that contain the asymptotic transport exponentials in all orders of approximation. Numerical calculations for standard transport problems showed that this asymptotic approximation is more accurate than the usual spherical harmonic method. (auth)

12464 THE NEUTRON SPECTRUM. A. Jannussis, A. Theophilou, and P. Tsilimigras (Democritus Nuclear Research Center, Athens). Nukleonik, 6: 368-9(Nov. 1964).

The problem of the neutron spectrum in an infinite homogeneous medium is considered. Two approximation methods are proposed, which are independent of resonance width. It is shown that the narrow resonance approximation is the first approximation of the perturbation method. (auth)

12465 DIFFUSION HEATING AND COOLING OF THERMAL NEUTRONS IN WATER. M. M. Bretscher and J. F. Meyer (Valparaiso Univ., Ind.). Proc. Indiana Acad. Sci., 73: (1963) 210-16(1964).

The diffusion heating effect of thermal neutrons in light water was investigated by measuring the diffusion length as a function of boric acid concentration. Diffusion lengths were obtained by a negative source technique while the boric acid concentrations were determined by both pulsed neutron methods and by direct chemical analysis. From these measurements the diffusion parameters of thermal neutrons in water were obtained. Preliminary results for the microscopic absorption cross section of hydrogen σ_a, the diffusion coefficient $\bar{D}_0$, and the diffusion heating coefficient C of light water are 0.323 ± 0.032 barn, 37,135 ± 1,196 $cm^2\ sec^{-1}$, and 2,836 ± 598 $cm^4\ sec^{-1}$ respectively. Pulsed neutron techniques were also used to obtain independent data for these same diffusion parameters with the results σ_a = 0.321 ± 0.005 barn, $\bar{D}_0$ = 37,651 ± 545 $cm^2\ sec^{-1}$, and C = 5,843 ± 887 $cm^4\ sec^{-1}$. Both sets of data are in favorable agreement with recently published results. (auth)

12466 ELASTIC SCATTERING OF NEUTRONS IN A CRYSTAL. J. A. Goedkoop (Reactor Centrum Nederland, Petten, Netherlands). p.534-59 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Processes in which a low-energy neutron creates a merely transient disturbance in the crystal lattice were considered. The limiting case in which no energy is transferred at all, elastic scattering, is discussed. Geometric conditions for elastic scattering are described. Scattering mechanisms are outlined. Neutron scattering is compared with x-ray scattering. Calculations are given for differential cross sections for a crystal. Scattered intensities and the effect of thermal motion on elastic scattering are discussed. Spin incoherence in scattering and magnetic scattering are also considered. (M.C.G.)

12467 SCATTERING OF NEUTRONS FROM MAGNETIC MATERIALS NEAR THEIR TRANSITION TEMPERATURE. B. Jacrot (Centre d'Etudes Nucléaires, Saclay, France). p.560-79 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Neutron scattering cross sections, which show a sharp maximum at the Curie point in magnetic materials, are discussed. A theory of neutron scattering by ferromagnetic materials is outlined. Experimental results for iron and nickel are analyzed. Scattering by antiferromagnetic materials, such as CoO, Fe_2O_3, and Cr_2O_3, is also considered. Relaxation time of the fluctuations, spin waves in the neighborhood of the Curie point, and order-disorder transitions are discussed. (M.C.G.)

12468 INELASTIC SCATTERING OF SLOW NEUTRONS. B. N. Brockhouse (McMaster Univ., Hamilton, Ont., Can.), S. Hautecler, and H. Stiller. p.580-642 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The scattering of thermal neutrons is discussed. Nuclear scattering, magnetic scattering, and coherent and incoherent scattering are considered. Experimental methods for obtaining the scattering function within certain regions of wave vector transfer and energy transfer are described. Pulsed-beam methods, polycrystalline filter methods, methods using triple-axis crystal spectrometers, and auxiliary experimental techniques are described and compared. Experiments to determine discrete frequencies for given momentum transfer, almost discrete frequencies for given

momentum transfer, continuous distribution of frequencies for given momentum transfer, and frequency distributions substantially independent of the momentum transfer are discussed. (94 references). (M.C.G.)

12469 THE SCATTERING OF COLD NEUTRONS BY DEFECTS AS A MEANS OF STUDYING RADIATION DAMAGE IN SOLIDS. D. G. Martin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.643-59 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The scattering of neutrons with wavelengths greater than about 1Å by point defects and defect clusters was studied. The theory of neutron scattering by defects is discussed and some experimental results are reviewed. Studies of radiation damage by cold neutron scattering techniques are summarized for Al_2O_3, quartz, BeO, and graphite. (M.C.G.)

12470 SOVIET PROGRESS IN NEUTRON PHYSICS. P. A. Krupchitskii, ed. Translation of Neitronnaya Fizika. New York, Consultants Bureau, 1963. 269p.

Separate abstracts for the forty papers on neutron fission thermalization, reactions, and scattering were previously prepared from the original Russian for NSA (15: 22962 and 16: 132, 1004, 1031, 1032, 1037, 1047, 2472, 2473, 2474, 2500, 2501, 2502, 2688, 9418, 9444, 9679, 29273, 29724, 29725, 29726, 29727, 29728, 29729, 29730, 29731, 29732, 29733, 29734, 29735, 29736, 29737, 29738, 29739, 29740, 29741, 29742, 29743, 29744, and 29745). (D.C.W.)

12471 INTRODUCTION TO NEUTRON DISTRIBUTION THEORY. L. C. Woods. Methuen's Monographs on Physical Subjects. London, Methuen and Co. Ltd. and New York, John Wiley and Sons Inc., 1964. 143p.

A brief account is presented of those elements of neutron transport, diffusion, and slowing-down theory that are relevant to the theory of reactors. The systematic derivation of the various equations used to determine the neutron flux distributions in energy and space is emphasized. (D.C.W.)

12472 GROUP CONSTANTS FOR NUCLEAR REACTOR CALCULATIONS. I. I. Bondarenko, ed. Authorized Translation from the Russian. Translation of "Gruppovye Konstanty Dlya Rascheta Yadernykh Reaktorov." New York, Consultants Bureau, 1964. 157p.

Multigroup systems of constants for fast and intermediate neutrons are tabulated. Principles in the compilation and use of multigroup systems of constants are outlined; specific formulas are included. 578 references. (D.C.W.)

12473 COHERENT SCATTERING OF SLOW NEUTRONS BY LIQUID SODIUM. K. S. Singwi and G. Feldmann (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/51, 25p. (CONF-804-8)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The convolution approximation proposed by Vineyard to treat the coherent scattering of slow neutrons by a monoatomic liquid is extended to take into account correlations between neighboring atoms. The correction to the convolution approximation is then evaluated on the basis of a "quasi-crystalline" model of a liquid. An expression for the inelastic differential scattering cross section is derived in the "one-phonon" approximation. It involves, beside other quantities, the Fourier transform of the velocity-autocorrelation function, the velocity of sound, and a parameter R corresponding to the range of order in a liquid. Explicit numerical calculations for the scattering functions $S(\alpha,\beta)$ were made for liquid sodium for various values of β as a function of α, and the results were compared with experiment. There is a general agreement between the calculated and observed values. This comparison seems to indicate that the velocity of sound is nearly 2×10^5 cm/sec (T = 100°C) for an angular frequency $\sim 5 \times 10^{12}$ sec^{-1} and R ~ 10 Å. Also, the generalized frequency distribution function has a maximum around $\omega = \omega_m \simeq 0.3\ k_B T/\hbar$ for T = 100°C. The available experimental results are too crude to permit a determination of the mean dispersion relation for "quasi-phonons" in liquid sodium. (auth)

12474 LIQUID HELIUM DISPERSION CURVE AT LARGE MOMENTUM. A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/4, 13p. (CONF-804-20)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Previous neutron inelastic scattering measurements of the energy (ϵ) vs momentum (p) dispersion curve for the elementary excitations in liquid helium II extended as far as $p/\hbar = 2.68$ $Å^{-1}$. For this value of momentum there was a strong suggestion that $d\epsilon/dp \to 0$ with a limiting value of $\epsilon = 2\Delta$, where Δ is the excitation energy at the minimum (the so-called "roton" minimum) of the dispersion curve. Such behavior was predicted by Pitaevskii who showed that a possible limiting form for the dispersion curve was $\epsilon(p) \to 2\Delta - \alpha \exp[-a/(p_c - p)]$ where α, a, and p_c are undetermined parameters. The parameter p_c, the value of p at which the dispersion curve terminates, must be less than $2p_0$, where p_0 is the value of p for which $\epsilon = \Delta$ (at the roton minimum). At the same time the intensities of the one-quantum neutron groups tend to zero as $(2\Delta - \epsilon)$ ln $^2[\alpha/2\Delta - \epsilon)]$. A series of experiments performed with the rotating crystal spectrometer at Chalk River covered the momentum range $1.8\ Å^{-1} < p/\hbar < 4\ Å^{-1}$. Qualitatively, the experimental results agree with the predicted behavior. The dispersion curve levels off and has a limiting energy of approximately 2Δ, and the intensities of the one-quantum neutron groups rapidly approach zero at large p, the intensity at $p/\hbar = 3.35$ $Å^{-1}$ being ~ 1% of the intensity at $p/\hbar = 1.91$ $Å^{-1}$. A quantitative comparison between theory and experiment is more difficult. The theoretical expressions contain three arbitrary parameters in addition to 2Δ, in such a way that it is difficult to determine them uniquely. There is a strong suggestion, however, that the maximum observed excitation energy ($\epsilon_{max} = 17.9 \pm 0.6$°K) does exceed $2\Delta(\Delta = 8.65 \pm 0.04$°K), but only by an amount which is at the limit of experimental error. The intensity measurements are not sufficiently accurate for a detailed comparison with theory. (auth)

12475 INELASTIC SCATTERING OF COLD NEUTRONS BY CONDENSED ARGON. N. Kroo, G. Borgonovi, K. Skoeld, and K. E. Larsson (Aktiebolaget Atomenergi, Studsvik, Sweden). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/17, 22p. (CONF-804-21)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The existence of collective modes of heat motion in liquids was investigated by neutron inelastic scattering measurements on liquid argon at 88°K temperature. As a comparison solid, polycrystalline argon (80°K) was also studied. The experiment was carried out with the time-of-flight spectrometer at the Studsvik R2 reactor. The incident neutron energy was 5 Mev, and the scattered neutron spectra were analyzed at 9 angles between 60 and 100°. The interference part of the scattering was used to obtain information about the collective motions of atoms in the two phases. The meaning of average dispersion relations is discussed, and methods by which these functions can be obtained are described. The results of such analysis are given for both the solid and liquid phase. Dispersion relations were obtained in both cases. The slopes of these curves at the origin are in good agreement with the sound velocities obtained by other methods. The results on liquid argon can be taken as a proof that the energy and momentum conservation relations were both active in the scattering process and as strong support for the idea of the existence of collective motions in a classical liquid. (auth)

12476 THEORY OF NEUTRON SCATTERING BY LATTICE VIBRATIONS IN IMPERFECT CRYSTALS. R. J. Elliott (Oxford Univ.) and A. A. Maradudin. Vienna,

International Atomic Energy Agency, 1964, Preprint No. SM-58/40, 20p. (CONF-804-11)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Theoretical formulas are derived for the one-phonon inelastic scattering cross section of neutrons by crystals containing a small finite concentration of impurities, on the assumption that the defect atoms have only a different mass from the atoms of the host crystal and that the force constants are unchanged. For defects of mass much lighter than the host, localized modes appear at frequencies well above the frequency band in the perfect lattice. The coherent cross section in this case shows that it should be possible to determine experimentally the spatial extent of the localized modes and to relate it to the frequency spectrum of the perfect lattice. The wave-like modes of the perfect lattice give, in principle, a coherent inelastic differential cross section at discrete frequencies which satisfy energy and wave vector conservation as determined by the frequency spectrum. In the presence of impurities these lines are shifted and broadened by the scattering of the lattice wave from the disordered array. The shift and broadening are calculated as the real and imaginary part of the self energy of the phonons to first order in the concentration c of impurities. For some defects, resonance modes occur within the frequency band and these are particularly well defined for impurity masses much greater than those of the host. The frequency shift shows a change in sign in passing from frequencies on either side of the resonance, and the width shows a maximum there. These effects should be observable and provide direct evidence of the resonance character of these modes. The incoherent scattering cross-sections reflect the change in the vibrational amplitudes of the atoms of the imperfect crystal, and under most circumstances lead to small effects at low concentrations. (auth)

12477 INTERFERENCE EFFECTS IN SLOW NEUTRON INELASTIC SCATTERING FROM POLYCRYSTALLINE SOLIDS. R. E. Schmunk, R. M. Brugger, and P. D. Randolph (Phillips Petroleum Co., Idaho Falls, Idaho). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/47, 17p. (CONF-804-6)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Slow neutron inelastic scattering measurements were made at the MTR on polycrystalline samples of Be and Al, both coherent scatterers. The inelastic scattering for both samples displays considerable structure which is directly related to the interference conditions for coherent scattering. Energy transfers observed in both experiments extend beyond the range for single phonon scattering, and the observed wave vector changes span the region in which interference effects are important. Details in the observed structure are correlated with the periodic nature of the reciprocal lattice, the polarization factor $(k \cdot \xi)^2$, the so-called "dynamic structure factor" $g_j^2(q)$, and the frequency distribution of the lattice vibrations. An attempt was made to obtain the frequency distribution from the data by applying the incoherent approximation, and it is concluded that this approximation can be relied on only to give the approximate locations of strong maxima and the approximate cut-off frequency of the distribution. (auth)

12478 INELASTIC SCATTERING OF SLOW NEUTRONS BY ETHYLENE. D. Bally, S. Todireanu, and V. Tarina (Inst. of Atomic Physics, Bucharest). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/33, 13p. (CONF-804-13)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The inelastic scattering of neutrons in ethylene was studied, using a triaxial spectrometer. The resolution of the spectrometer in the incident neutron energy range explored, expressed by the ratio $\Delta E/E$, where ΔE is the total half-height width of the curve describing the energy distribution of the neutrons scattered by vanadium, was below 0.12. Incident neutron energies 22 to 72 Mev and scattering angles 5° to 90° were used. At the upper limit of the energy range studied, good agreement is observed between the experimental data and the theoretical curve of Krieger and Nelkin. For lower incident neutron energy values, the curve representing the experimental data has a shape similar to that observed by Randolph for methane; the half-height width of the experimental curve is less than the theoretical width calculated by the Krieger-Nelkin formula. This discrepancy between experimental and theoretical data is probably due to the discrete structure of the molecular rotation levels and shows that in this case the formula proposed by Griffing should be used. Measurements carried out on methane gave partial differential cross-section values which were in agreement with those of Randolph and which, in the region of maximum, are different from those calculated by Griffing. It is probable that stricter treatment of the contribution from the resolving power of the apparatus would improve the degree of agreement between the theoretical and experimental data. Curves S (d) were drawn for different values of the parameter β, and for low values of β satisfactory agreement with the theoretical curves under the Krieger–Nelkin formula was obtained. (auth)

Nuclear Properties and Reactions

Refer also to abstracts 11165, 11205, 11516, 11525, 11526, 11561, 11570, 11577, 11660, 12176, 12264, and 12470.

12479 (AFCRL-64-840) PHYSICS OF THE MÖSSBAUER EFFECT. Physical Sciences Research Papers No. 58. Leonard J. Eyges (Air Force Cambridge Research Labs. Laurence G. Hanscom Field, Bedford, Mass.). Oct. 1964. 37p. (AD-608416).

The "recoilless emission" of gamma rays from a nucleus bound in a crystal lattice is studied. A discussion is given of the kinematics of gamma emission from such a nucleus. The idealized case of a massive "lattice" characterized by a single frequency, and more realistic one- and three-dimensional models are treated. It is noted that in the Mössbauer effect the lattice as a whole (the lattice center of mass) always recoils after photon emission so that the term "recoilless emission" is in one sense misleading. The essence of the Mössbauer effect is not photon emission without recoil, but rather is photon emission without transfer of energy to internal degrees of freedom of the lattice. Using the basic ideas of quantum mechanics, namely, the rules for the manipulation of probability amplitudes (the so-called "transformation theory"), the probability is calculated for recoil without excitation of internal degrees of freedom, i.e., the Mössbauer f-factor, on the assumption that the individual photon emissions, consequent lattice recoil, are instantaneous. Instantaneous emission is discussed, in some detail, and it is shown that it is not in contradiction with the fact that the nuclear transition that leads to the gamma emission has a finite half-width. (auth)

12480 (AWRE-O-79/64) NEUTRON CROSS SECTIONS OF Pu-239 IN THE ENERGY RANGE 1 Kev TO 15 Mev. A. C. Douglas and J. F. Barry (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Jan. 1965. 113p. Dep.(mn).

Values are recommended for the neutron total and partial cross sections of Pu-239 in the energy range 1 kev to 15 Mev. The available experimental evidence is surveyed and is supplemented by estimates based on nuclear theory. Details of energy and angular distributions are given so that the data are complete for the purposes of neutronics calculations. The values given have been combined with data below 1 kev, and have been written on punched cards. (auth)

12481 (AWRE-O-91/64) NEUTRON CROSS SECTIONS OF Pu-240 IN THE ENERGY RANGE 1 Kev to 15 Mev. A. C. Douglas (United Kingdom Atomic Energy Authority.

Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Jan. 1965. 73p. Dep.(mn).

Values are recommended for the neutron total and partial cross sections of Pu-240 in the energy range 1 kev to 15 Mev. The scant experimental evidence is surveyed and supplemented by estimates based on nuclear theory. Details of energy and angular distributions are given so that the data are complete for the purpose of neutronics calculations. The values given in this report have been combined with data below 1 kev and have been written on punched cards. (auth)

12482 (JINR-E-1861) INVESTIGATION OF THE α-SPECTRUM OF Gd^{149}. T. Fényes, I. Mahunka, and M. Mahunka (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 6p. Dep.(mn).

The α spectra of ^{149}Gd and ^{148}Gd produced by proton spallation of Ta at 660 Mev were studied. The measurements were made with a semiconductor α spectrometer. (auth)

12483 (JINR-P-1846) ISSLEDOVANIE SKHMEY RASPADA Tb^{152}. (An Investigation of the Decay Mode of Tb^{152}). K. Ya. Gromov, D. A. Enchev, Zh. T. Zhelev, I. Zvol'skii, V. G. Kalinnikov, V. V. Kuznetsov, Ma Huo Ik, G. Muziol, and Shu-jun Han (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 22p. Dep.(mn).

The conversion electron and positron spectra of ^{152}Tb were investigated. The γ and γ-γ-coincidence spectra were studied, as well as the spectrum of the annihilation γ quanta coincident with the ^{152}Tb γ rays. On the basis of the energy balance, spectra of γ rays, γ-γ coincidences, and β^+-γ coincidences, as well as the balance of intensities, it is supposed that there exist the following excited states of ^{152}Gd with energies: 1110(1−); 1606.7; 1863; 1942; 2137; 2248; 2412; 2457; 2526; 2667; 2714; 2803; and 3160 kev. (auth)

12484 (JINR-P-1852) O RASPADE Er^{161}. (Decay of Er^{161}). K. Ya. Gromov, Zh. T. Zhelev, V. Zvol'ska, and V. G. Kalinnikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 24p. Dep.(mn).

A positron spectrum of ^{161}Er was observed by means of a triple-focusing magnetic spectrometer. Results concerning the conversion electron spectrum are presented. Conclusions are drawn on the multipolarities of some transitions. The decay scheme of $^{161}Er \rightarrow {}^{161}Ho$ has been developed. The 1897-kev and 1943-kev levels are interpreted as three-quasi-particle states. (auth)

12485 (JINR-P-1865) PROTONNYI IZLUCHATEL—PRODUKT REAKTSII Ru + O^{16}. (A Proton Emitter—A Product of the Ru + O^{16} Reaction). V. A. Karnaukhov, G. M. Ter-Akop'van, L. A. Petrov, and V. G. Subbotin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 7p. Dep.(mn).

A Ru target was bombarded with 70 to 90-Mev ions of ^{16}O. Among the nuclear reaction products were recorded two proton emitters with half lives 60 ± 10 and 11 ± 2 sec. The energy spectrum of protons consists of a number of lines in the range of 2 to 4.5 Mev, which have not been separated. Preliminary experiments allow the identification, with the best probability possible, of the 11-sec emitter as a Te isotope with mass number 109 to 111. (auth)

12486 (JINR-P-1883) O RASPADE Ho^{161}. (On the Decay of Ho^{161}). A. A. Abdurazakov, K. Ya. Gromov, V. V. Kuznetsov, Ma Ho Ik, G. Muziol, F. Molnar, A. Molnar, F. Mukhtasimov, and Shu-jun Han (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 15p. Dep.(mn).

The spectra of γ rays and electrons from the ^{161}Ho decay have been studied. New γ transitions of ^{161}Ho which have energies of 210.8, 234.5, 239.7, 339.7, 416.0, and 760.0 kev have been observed. The relative intensities of γ rays and the conversion electrons of ^{161}Ho have been measured. The lifetime is measured as $(8.9 \pm 0.2) \times 10^3$ sec. The multipolarities of a number of γ transitions of ^{161}Ho have been determined. On the basis of the data, the decay mode of ^{161}Ho has been analyzed. (auth)

12487 (LAL-1115) EXPERIENCES DE COINCIDENCES (e,e'p) SUR LE DEUTERIUM. (Experiments on (e,e'p) Coincidences on Deuterium). Paul Bounin (Paris, Université, Orsay. Ecole Normale, Supérieure. Laboratoire de l'Accelerateur Linéaire) and Michel Croissiaux (Strasbourg. Université. Centre de Recherches Nucléaires). Oct. 1964. 31p. Dep.(mn).

Electron-proton coincidence experiments were made for an electron energy of 350 Mev, but with protons having variable energy. Comparison with theory would allow the deduction of conclusions on the form factor of the bound proton. The expression for the differential cross section was given and some theoretical considerations that make it possible to define the approximations were reported. The experimental apparatus and methods were described. The experimental results and conclusions were discussed. (tr-auth)

12488 (ORNL-3631) EVIDENCE OF THE ABSENCE OF LONG-LIVED ISOTOPES OF PROMETHIUM FROM FISSION OF URANIUM, AND THE PURIFICATION OF PROMETHIUM FOR THE ESTABLISHMENT OF A PRIMARY SPECTROGRAPHIC STANDARD. P. B. Orr, R. S. Pressly, and E. J. Spitzer (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 21p. Dep.; $2.00(OTS).

A sample of high-purity promethium, produced by uranium fission, was separated by ion exchange on Dowex 50 W-X4 hydrogen-form resin, with diethylenetriaminepentaacetic acid and citric acid as eluants. Within the limits of detection, no isotope of promethium with a half life of greater than 2.6 yr was found in the product which had decayed through two half lives of ^{147}Pm. The promethium contained only traces of yttrium, samarium, and neodymium and was of sufficient purity to establish spectra for a promethium standard. (auth)

12489 (ORNL-3673) ISOTOPES—A PROGRAM FOR NEUTRON PRODUCT YIELDS AND DECAY CALCULATIONS USING A CONTROL DATA 1604-A COMPUTER. Charles W. Friend and Alton R. Jenkins (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 25p. Dep.; $2.00(OTS).

A computer program was developed to calculate the optimum time of neutron irradiation for maximum yield, the specific activity of the product isotope in curies per gram of target material, and the combined specific activity of the target and product isotopes for any general first-order reaction or decay problem. The program was written in the FORTRAN-63 language for the Control Data 1604-A computer. (auth)

12490 (ORNL-3689) ISOCRUNCH—MODIFICATIONS TO THE CRUNCH PROGRAM FOR THE IBM 7090. Charles W. Friend and J. R. Knight (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 36p. Dep.; $3.00(OTS).

The IBM 7090 code ISOCRUNCH was developed by adding optional programs to the basic CRUNCH code and modifying the input and output data formats. ISOCRUNCH can be used to compute the amount of each isotope in a reaction and decay chain for any specified neutron flux and time, to sum the contributions of various chains to the same isotope, to plot the yield of an isotope vs. time for a given flux, and to find the optimum time for maximum yield of an isotope in a chain. The basic theory and use of ISOCRUNCH are described, with sample problems and the FORTRAN calling program included. (auth)

12491 (ORNL-3727) ELASTIC AND INELASTIC SCATTERING OF 8- TO 15-Mev DEUTERONS FROM ^{116}Cd: TABULATED DIFFERENTIAL CROSS SECTIONS. J. K. Dickens and F. G. Perey (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 16p. Dep.; $1.00(OTS).

A tabulation is presented of numerical values of dif-

ferential cross sections of deuterons elastically and inelastically scattered from ^{114}Cd. The cross sections were determined at 5° intervals between laboratory angles of 20 and 160° for incident energies of 7.96, 8.97, 9.97, 10.99, 12.0, 13.0, 14.0, and 15.0 Mev. The inelastic-scattering data are for deuterons inelastically scattered from the first excited state of ^{114}Cd (Q = −0.554 Mev). (auth)

12492 (ORNL-TM-1024(Rev.1)) CHANGES IN URANIUM ISOTOPIC COMPOSITION OF IRRADIATED ThO_2–UO_2 FUEL SAMPLES. J. H. Goode (Oak Ridge National Lab., Tenn.). Jan. 29, 1965. Contract W-7405-eng-26. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Nine irradiated 96% ThO_2–4% UO_2 specimens, containing 93%-enriched uranium prior to irradiation, were dissolved in fluoride-catalyzed nitric acid. Changes in the uranium isotopic composition are tabulated as a function of irradiation from 3000 to 99,000 Mwd/metric ton (Th + U). At 99,000 Mwd/metric ton, the uranium had changed from 93% ^{235}U–7% ^{238}U to about 52% ^{233}U–17% ^{234}U–3% ^{235}U–20% ^{236}U–9% ^{238}U. The isotopic composition of the plutonium, a very minor constituent, at 99,000 Mwd/metric ton was about 40% ^{238}Pu–35% ^{239}Pu–13% ^{240}Pu–5% ^{241}Pu–7% ^{242}Pu. (auth)

12493 (PAN-537/VI) A COMPARISON OF ANGULAR DISTRIBUTION OF SECONDARY PARTICLES IN ULTRA-HIGH ENERGY JETS WITH THE QUASI-RECTANGULAR DISTRIBUTION PREDICTED BY THE MODIFIED STATISTICAL MODEL. J. Babecki and M. Mięsowicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1964. 10p. Dep.

Ninety jets ($E_p \geq 10^{12}$ ev), with $5 \leq n_s \leq 20$ and limited number of evaporation tracks ($N_h \leq 5$), have been analyzed in order to compare the angular distributions of secondary particles with the quasi-rectangular angular distribution predicted by a modified statistical model with independent emission of particles. The analysis has shown a very significant deviation of the observed angular distributions from the quasi-rectangular form. The deviation is of the type predicted by the fire-ball model. (auth)

12494 (AEC-tr-6227/3(p.157-66)) BETA DECAY OF Nd-147. M. T. Župančić. Translated from Bilten Inst. Nukl. Nauke "Boris Kidric," 15: 157-66(1964).

The beta spectrum of ^{147}Nd was analyzed. Transitions of 806 kev (log ft = 7.5), 526 kev (log ft = 7.8), 369 kev (log ft = 7.0), and 224 kev (log ft = 6.4) were found. Beta-gamma coincidence measurements with gamma rays of 91, 530, and 320 kev were performed. (auth)

12495 (AEC-tr-6227/3(p.167-72)) HEAVY PARTICLE STRIPPING IN N^{14} (d,p) N^{15} REACTION AT DEUTERON ENERGIES OF ABOUT 1 Mev. D. M. Stanojević. Translated from Bilten Inst. Nukl. Nauke "Boris Kidric," 15: 167-72(1964).

Angular distribution of protons from the $^{14}N(d,p)^{15}N$ reaction was analyzed by deuteron and heavy particle stripping using the simple formula suggested by Owen and Madansky. The ratio of the amplitudes of these effects determined by the least square method shows a tendency to increase with increasing deuteron energy. (auth)

12496 CROSS-SECTIONS OF PHOTONUCLEAR REACTIONS TABULATED EXPERIMENTAL DATA. B. I. Goryachev (Moscow State Univ.). At. Energy Rev., 2: No. 3, 71-148(1964).

A summary of experimental results relating to the thresholds, cross-sections and yields of photonuclear reactions is presented. Work published in periodicals up to the middle of 1963 is tabulated and is based on a breakdown of the experimental material by elements (from sodium to the transuranium elements), the papers relating to each element being arranged in alphabetical order. Except for a few old papers, the data contained in all published works were used, provided they could be adapted to the tabular arrangement employed. 214 references are included. (auth)

12497 SELF-CONSISTENT TREATMENT OF INTERACTIONS OF ORDINARY AND COUPLING TYPES FOR DEFORMED NUCLEI. Jean Pradal. Cahiers Phys., 18: 137-71(Apr. 1964). (In French)

Two nuclear pairing formalisms, with and without conservation of the number of particles, respectively, were developed on the basis of superconductivity theory. The formalism without conservation of the number of particles was used to study the deformation of nuclei from ^{132}Sn to ^{208}Pb. Some encouraging results were obtained. Preliminary results obtained with the other model are briefly discussed. (D.C.W.)

12498 EFFECTS OF N ± 2 SHELLS ON THE E1 TRANSITIONS IN ODD NUCLEI IN THE RARE-EARTH REGION. Robert Piepenbring (Centre de Recherches Nucleaires, Strasbourg). Compt. Rend., 259: 2799-2800(Oct. 28, 1964). (In French)

The effects of N ± 2 shells on the ΔK = ±1 transitions of ^{175}Lu, ^{177}Lu, ^{173}Yb, ^{177}Hf, the ΔK = 0 transition of ^{173}Yb, and the E1 transitions of ^{179}Hf and ^{181}Ta were studied. Except for the ΔK = 0 transition of ^{173}Yb, which is well explained by the Nilsson model, the consideration of these shells reduces the deviation from experience. (J.S.R.)

12499 DETERMINATION OF THE CROSS SECTION OF THE REACTION $^{12}C(\gamma,3\alpha)$ PRODUCED BY γ RAYS AT 17.6 Mev IN AN ORGANIC SCINTILLATOR. Guy Walter and Andre Coche (Centre de Recherches Nucleaires, Strasbourg). Compt. Rend., 259: 2817-20(Oct. 28, 1964). (In French)

The cross section of the reaction $^{12}C(\gamma,3\alpha)$ in stilbene was determined by using a form discrimination technique. The results showed that it is possible to distinguish the pulses due to alpha particles from those due to electrons and to protons. The alpha peak that appeared in the (Y = 6) spectrum (one distinct value of the fast component) corresponds to an energy of 8 ± 0.5 Mev. A value of 2.06 ± 0.4×10^{-28} cm^2 was obtained for the cross section of the reaction $^{12}C(\gamma,\alpha)^8Be^* \rightarrow 2\alpha$ at 17.6 Mev. (J.S.R.)

12500 GENERAL PROPERTIES CONCERNING THE EMISSION OF HYPERNUCLEI IN THE INTERACTIONS OF K^- MESONS OF 5 Gev/c WITH IONOGRAPHIC EMULSION NUCLEI. Germain Baumann, Jean-Paul Gerber, Henri Braun, and Pierre Cueer. Compt. Rend., 259: 2821-4 (Oct. 28, 1964). (In French)

The rate of production of hypernuclei decreases when the incident energy increases. At 5.0 Bev/c, it is 1.8 ± 0.3%. The number of heavy hypernuclei decreases in favor of hypernuclei of medium mass when the incident energy increases and as the primary energy spent augments. The primary energy transmitted is higher in interactions with hypernuclei than in those without hypernuclei. (tr-auth)

12501 MEASUREMENT OF THE FISSION CROSS SECTION OF PLUTONIUM-239 BY SLOW NEUTRONS. Gérard de Saussure, Jacques Blons, Claude Jousseaume, André Michaudon, and Yves Pranal. Compt. Rend., 259: 3498-3500(Nov. 16, 1964). (In French)

The fission cross section of ^{239}Pu was measured between 0.16 ev and 5 kev by the time-of-flight method with a gaseous scintillator containing 310 mg of ^{239}Pu. Under the best conditions and at high energy, the measurement resolution was 3 nsec/m. (tr-auth)

12502 EVIDENCE OF EXCITED STATES OF ^9Be AND ^8Be IN THE REACTION $^9Be(n,2n)$ WITH NEUTRONS AT 14 Mev. Robert Bouchez, Jean-Claude Gondrand, Paul Perrin, Claude Perrin, Alain Giorni, Pierre Quivy, and Michel Dubus (Centre d'Etudes Nucléaires, Grenoble, France and Faculté des Sciences, Grenoble, France). Compt. Rend., 259: 3501-3(Nov. 16, 1964). (In Frence)

With the aid of a double time-of-flight spectrometer, it was observed that the reaction $^9Be(n,2n)$ is produced principally with formation of resonant states of $^9Be^*$ (6.76 Mev, 7.94 Mev, etc.) and only slightly by the direct processes $^8Be(O) + n_1 + n_2$, corresponding to the ejection by an incident neutron at 14.5 Mev of the slightly bound peripheral neutron (1.66 Mev) of ^9Be. (tr-auth)

12503 ON RELATIVISTIC WAVE FUNCTIONS CONSIDERING FINITE NUCLEAR DIMENSIONS. A. F. Babushkin. Czech. J. Phys., 14: 886-8(1964). (In Russian)

Relativistic wave functions considering the dimensions of the nucleus were found without using Zommerfeld assumptions in which the main quantum number differs from the finite nuclear dimensions by a small magnitude Δn. The wave functions were determined using the equations of the external and internal wave functions as the boundary of the nucleus. (R.V.J.)

12504 EFFECT OF THE DIFFUSE SURFACE BOUNDARY OF THE NUCLEUS ON THE β DECAY. B. D. Fiz. Szemle, 14: 260(Aug. 1964). (In Hungarian)

The fields of the nucleus and of the atomic shells affect markedly the energy distribution of the beta particles formed in the nucleus. Thus, if Z is large and E_{max} is low, the negative beta spectrum intensity will not fall to 0 at 0 energy; and the energy distribution obtained differs from the usual shape of the beta spectrum. This anomaly is not noted when magnetic spectrometers are used. Therefore, the size and the charge distribution affects various beta-decay phenomena, such as the form factor, beta-angular correlation, and the angular distribution. It was assumed earlier that the nucleus possesses a well-defined surface boundary and its charge distribution is constant, but more recently it has been established that the surface of the nucleus is diffuse and the charge distribution is nonuniform. Vinduska presented calculations on the beta decay in which these effects were taken into account. His results indicate that consideration of the diffuse nature of the boundary of the nucleus causes variations of up to 20% in the form factor of the spectrum. (TTT)

12505 NUCLEAR SPIN RESONANCE. V. S. Grečiškin and N. E. Ajnbinder. Fortschr. Physik, 12: 441-86(1964). (In German)

Research on nuclear spin resonance is reviewed. The relation of energy levels and frequency of the nuclear spin resonance and the relative intensities of nuclear spin resonance lines are discussed. The temperature dependence of the absorption frequency and the theory of nuclear spin lattice relaxation are considered. Experimental studies using nuclear spin resonance and experimental quadrupole interaction constants are discussed. (131 references) (M.C.G.)

12506 BETA-GAMMA ANGULAR CORRELATIONS AND NUCLEAR STRUCTURE PROBLEMS. Masato Morita (Kyoto Univ.). Genshikaku Kenkyu, 9: No. 1, 3-11(Apr. 1964). (In Japanese)

The theory of beta-gamma angular correlations is discussed. In order to determine the magnitudes of nuclear matrix elements involved in the theory of beta decay, completed experiments must be performed. Importance of the finite size correlation in analysis of experimental data is stressed. Recent experiments on ^{140}La by Neusome and Fischbeck are shown. Their data were analyzed using formulas of Morita and Morita and numerical tables of Bhalla and Rose. Nuclear matrix elements obtained in this way can be compared with theoretical values. (auth)

12507 PROTON-NEUTRON CORRELATIONS AND BETA DECAYS. Kiyomi Ikeda and Junichi Fujita (Nihon Univ., Japan). Genshikaku Kenkyu, 9: No. 1, 48-82(Apr. 1964). (In Japanese)

It is shown that the neutron-proton correlations play a significant role for beta decays in heavier nuclei. Existence of the well-defined isobaric state is very important for beta decay theory, because the transition matrix to the isobaric state exhausts the sum rule for f^1. Simple soluble models are discussed, which are based on the Fermi gas model. This simple model makes clear the relation of the energy of the (N − 1, Z + 1) core polarized state to the strength of residual interactions. The effect of the nuclear core polarization on the beta decay of an outside nucleon is discussed by using this model. It was concluded that the existence of the nuclear core polarization effect is consistent with the systematics of ft-values. Allowed beta transition of the G-T type in the Sb region were investigated with a more realistic model in which the pairing correlation between identical nucleon J = 0 pairs and the neutron-proton pair correlation were taken into account. As a result of the effect of pair correlation and the nuclear core polarization effect due to the p−n interaction between the unlike nucleon pairs with $J^\pi = 1^+$, the experimental ft-value can be fairly explained. (auth)

12508 SECONDARY ELECTRON YIELD FROM FISSION FRAGMENTS. F. E. Jamerson, C. B. Leffert, and D. B. Rees (General Motors Corp., Warren, Mich.). J. Appl. Phys., 36: 355-6(Feb. 1965).

The secondary electron yield from fission fragments was measured directly using an ultrahigh-vacuum diode containing uranium which was operated in a nuclear reactor. The current measured in this diode consisted of contributions from the positively charged fission fragments, secondary electron emission induced by fission fragments, and photoelectrons generated by gamma radiation. The secondary electron yield Δ was determined from the secondary electron current and the computed fission fragment emission rate. For a thick (>one range) uranium−nickel (5.7 wt. % nickel) alloy the value of Δ is 207 ± 10. (auth)

12509 STOPPING CROSS SECTION OF LOW ATOMIC NUMBER MATERIALS FOR He PLUS, 65-180 kev. R. Dale Moorhead (Ames Research Center, Moffett Field, Calif.). J. Appl. Phys., 36: 391-5(Feb. 1965).

Stopping cross sections were measured for H_1^+ in carbon and for He^+ in carbon, aluminum, and chromium over the energy range of 65 to 180 kev. Layers of the stopping materials were evaporated in vacuo onto a gold-plated quartz crystal and their areal densities were computed from the shift in the resonant frequency of the crystal. The energy lost by the ions in the stopping material was determined by measuring the energy of the scattered ions. Experimental results show a divergence from available theory above 80 kev. (auth)

12510 SPIN-LATTICE RELAXATION TIME FOR NUCLEI WITH SPINS ½ AND ⅝. I. P. Biryukov (Inst. of Organic Synthesis, Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad., Vestis, Fiz. Tek. Zinatnu Ser., No. 4, 125-6(1964). (In Russian)

Equations are given for calculating spin-lattice relaxation times for nuclei with spins ½ and ⅝. (M.C.G.)

12511 MEASUREMENTS OF Si(n,p)Al AND Si(n, ALPHA)Mg REACTIONS IN THE NEUTRON ENERGY RANGE 5.2 TO 9 Mev. G. Andersson-Lindstroem*, G. Betz, W. Mausberg, and E. Roessle (*Institut fur Experimentalphysik, Hamburg). Mem. Soc. Roy. Sci. Liege, 10: No. 2, 265-76(1964).

The cross sections where the final nuclei remain in the lowest excited states were measured for the reactions ^{28}Si(n,p)^{28}Al, ^{28}Si(n,α)^{25}Mg, and ^{29}Si(n,α)^{26}Mg. The range of incident neutron energy was $5.2 < E_n < 9$ Mev. The measurements were performed by bombarding a solid state detector with neutrons having an energy spread of 30 to 50 kev. (auth)

12512 LIFETIME MEASUREMENTS USING A NEW METHOD OF BEAM PULSING. J. Dubois (Chalmers Univ. of Tech., Goteborg). Nucl. Instr. Methods, 31: 322-4 (Dec. 11, 1964).

By pulsing the energy of the beam from a Van de Graaff generator it was possible to measure lifetimes of metastable levels produced by resonance reactions. Special attention was paid to the background problem. (auth)

12513 EFFECT OF SOURCE THICKNESS ON THE MEASURED BETA-GAMMA DIRECTIONAL CORRELATION. B. Martin and P. Schmidlin (Max-Planck-Institut fur Kernphysik, Heidelberg). Nucl. Instr. Methods, 32: 210-12(Feb. 1965). (In German)

The effect of source thickness on the measured anisotropy of a β-γ directional correlation was studied in the case of ^{86}Rb. RbCl sources of 0.3, 0.9, 4.2, and 13 mg/cm² were

used. A strong attenuation of the correlation was found with increasing source thickness. The results are compared with a recently published theory taking into account multiple scattering only. (auth)

12514 ANALYZING POWER OF CARBON FOR INCIDENT PROTONS BETWEEN 440 AND 640 Mev. R. D. Eandi, R. W. Kenney, and V. Z. Peterson (Univ. of California, Berkeley). Nucl. Instr. Methods, 32: 213-16 (Feb. 1965). (UCRL-11489)

The effective analyzing power of carbon for polarized protons in the energy range 440 to 640 Mev was measured as a function of proton scattering angle. The measurements were made by observing the azimuthal scattering asymmetry produced by a 650 Mev, 75% polarized beam of protons in a large carbon-plate spark chamber. No attempt was made to separate out the contribution of inelastic channels which resemble proton-carbon scattering. An enhancement of p-C analyzing power in the neighborhood of 650 Mev is observed, and a possible explanation of this effect is discussed. (auth)

12515 NUCLEAR FLUORESCENCE OF THE 2.13 Mev STATE OF B^{11}. E. F. Kennedy and W. C. Miller (Univ. of Notre Dame, Ind.). Nucl. Phys., 63: 634-40(Mar. 1965).

Nuclear fluorescene of the 2.13 Mev state of ^{11}B was observed using the bremsstrahlung beam from an electron Van de Graaff. Using a self-absorption technique, the mean life of this state was determined to be $(4.8 \pm 0.7) \times 10^{-15}$ sec. (auth)

12516 FINE STRUCTURE OF THE GIANT RESONANCE IN THE REACTION $P^{31}(p,\gamma_0)S^{32}$. G. Dearnaley, D. S. Gemmell, B. W. Hooton, and G. A. Jones (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 64: 177-96(Apr. 1965).

The excitation function of the reaction $^{31}P(p,\gamma_0)^{32}S$ was measured at 90° over the range $E_p = 2$ to 11.5 Mev. The yield exhibits many peaks, in the form of sharp resonances at low energies, but broader and overlapping more at the higher energies. Angular distributions were taken on and near the peaks. The peaks are interpreted as resonances rather than fluctuations. Interpretation of the angular distributions, which are all dominated by a large $\sin^2\theta$ term indicative of electric dipole capture, requires a breakdown of the statistical theory of level widths. It is shown that external channel contribution to the capture process, though not negligible, is insufficient to account for the results observed. (auth)

12517 CAPTURE OF OUTER ORBITAL ELECTRONS. Berol L. Robinson (Western Reserve Univ., Cleveland). Nucl. Phys., 64: 197-208(Apr. 1965).

Theoretical electron capture rates are given for all electrons captured in unique second and third forbidden transitions. The M_I/L_I capture ratios and M subshell capture ratios are tabulated for $55 \leqq Z \leqq 90$, and capture from the N, O, and P shells is estimated. The available experimental data on ^{138}La and ^{209}Po are re-interpreted in the light of these results, and M/L capture ratios are given as functions of transition energy for the low-energy capturers ^{193}Pt, ^{202}Pb, and ^{205}Pb. Comparative half lives of unique second and third forbidden transitions are tabulated and discussed in connection with ^{138}La decay. (auth)

12518 THE DECAY OF NEUTRON-DEFICIENT Er AND Ho NUCLIDES. T. Stenstroem and B. Jung (Uppsala Univ.). Nucl. Phys., 64: 209-30(Apr. 1965).

The conversion electron spectrum between 15 kev and 1 Mev of ^{158}Er, ^{159}Er, and ^{161}Er and their daughters was measured in a double focussing β-spectrometer. By applying a fast radiochemical separation method, the ground states of ^{158}Ho, ^{160}Ho, and ^{162}Ho could be separated from the more long-lived isomers and their half lives measured to be 10.9 ± 0.6, 25.6 ± 0.3, and 15 ± 1 min, respectively, as observed in a γ-spectrometer. By similar techniques the half life of ^{161m}Ho was found to be 6.80 ± 0.10 sec. The γ spectrum of ^{163}Er was studied and new γ transitions found with energies 290, 510, and 885 kev. The half life of ^{163}Er was measured to be 74 ± 2 min. The activities were produced in synchrocyclotron bombardments of Ho with protons of energies varying between 50 and 100 Mev. A special technique allowed a fifty-fold increase in the specific activity of the lanthanide fraction prior to ion exchange fractionation without appreciable loss in total activity. The radiochemical isolation of the ^{158}Ho, ^{160}Ho, and ^{162}Ho ground states and the ^{161}Ho isomeric state was achieved by extraction into water of the decay products from a Ho (or Er) phthalocyanine solution. (auth)

12519 CALCULATION OF ELECTRON SCATTERING FROM PARTIALLY ALIGNED NON-SPHERICAL NUCLEI. L. E. Wright and D. S. Onley (Duke Univ., Durham, N. C.). Nucl. Phys., 64: 231-40(Apr. 1965).

The differential cross section for scattering of high-energy electrons ($E_e \approx 200$ Mev) from partially aligned nonspherical nuclei is calculated. The nuclei are represented by the Bohr-Mottelson model in the strong coupling limit, and the cross section calculated by the distorted wave treatment of electron scattering. Analysis of the measured cross section for nonaligned ^{181}Ta gives an intrinsic quadrupole moment of 7 μ_B (comparable with other measurements). The expected dependence of the cross section of the direction and degree of alignment of a similar nucleus, ^{165}Ho, is discussed, In particular, for 50% alignment of ^{165}Ho perpendicular to the incident beam, the cross section should display measurable azimuthal asymmetry. (auth)

12520 POLARIZATION OF PROTONS FROM THE $^{40}Ca(d,p)^{41}Ca$ REACTION. Syohei Kato, Noriaki Takahashi, Minoru Takeda, Takashi Yamazaki, and Satoshi Yasukawa (Osaka Univ.). Nucl. Phys., 64: 241-58(Apr. 1965).

The angular dependence of the differential cross section and polarization of protons for the reaction $^{40}Ca(d,p)^{41}Ca$ was observed at incident deuteron energies of around 11 Mev. The differential cross sections were measured at deuteron energies of 11.2, 11.0, 10.85, 10.65, and 10.4 Mev and between 20° and 145°. The polarization was measured at a mean incident energy of 10.9 Mev and between 20° and 130°, using a carbon polarimeter and NaI scintillation counters. There is fairly large polarization at backward angles, and according to the Basel convention the sign of polarization is negative at all angles. Experimental differential cross sections were compared with DWBA computation which incorporated only a central distorting potential. (auth)

12521 WIDE-ANGLE SCATTERING OF 43 Mev ALPHA PARTICLES BY ^{58}Ni. H. W. Broek (Argonne National Lab., Ill.), J. L. Yntema, B. Buck, and G. R. Satchler. Nucl. Phys., 64: 259-72(Apr. 1965). (ORNL-P-565)

Elastic and inelastic scattering of 43-Mev alpha particles by ^{58}Ni was observed over the angular range from 15° to 142° cm. Angular distributions were derived for elastic scattering and for inelastic scattering to the 2^+ first excited level at 1.45 Mev, the two-phonon group at 2.47 Mev, and the strong 3^- level at 4.45 Mev. The angular distributions show strong oscillations (with a period of 10°) at angles less than about 70°, but the oscillations become less pronounced for angles greater than 70°. The oscillation period tends to increase with increasing angle to a value of about 15° at the largest angles observed. Optical model analysis of the elastic scattering was made, and the inelastic scattering to the 2^+ and 3^- levels calculated using the distorted-wave method. A coupled-channel analysis of the elastic scattering and inelastic scattering to the 2^+ and 4^+ levels was also undertaken. Good agreement with experiment is found in all cases. It was found necessary to use an optical potential in which the absorptive potential has a somewhat different shape than the real potential. There is also some indication that better results are obtained by using a complex coupling in the distorted-wave calculations. (auth)

12522 MEDIUM-ENERGY DEUTERON-CARBON ELASTIC SCATTERING. L. J. Campbell (Univ. of California, San Diego, La Jolla). Nucl. Phys., 64: 173-88(Apr. 1965).

Optical potentials for deuteron-carbon elastic scattering at 125, 156, and 422 Mev (lab) are obtained in terms of the two-nucleon scattering amplitude and nuclear form factors. The absolute cross section and vector and tensor polarizations are calculated using complex WKB phase shifts for 50 partial waves. The predicted cross sections agree well with experiment except at high scattering angle. The vector polarizations agree in magnitude, while the tensor polarizations are much smaller than experiment. (auth)

12523 THE DECAY OF Ge^{78}. K. Fritze (McMaster Univ., Hamilton, Ont.). Nucl. Phys., 64: 303-9(Apr. 1965).

The decay of ^{78}Ge was studied using scintillation techniques. The half life was found to be 88 ± 2 min. A strong γ ray of 279 ± 2 kev is associated with the decay of ^{78}Ge. The β spectrum in coincidence with this γ ray has an endpoint of 693 ± 30 kev, indicating a Q_β value of 972 ± 30 kev. (auth)

12524 THE NILSSON NUCLEAR MODEL INCLUDING NON-DIAGONAL ELEMENTS. D. Grau and O. Hittmair (Technische Hochschule, Vienna). Nucl. Phys., 64: 310-20 (Apr. 1965). (In German)

The bound states of the Nilsson model are obtained, taking into account nondiagonal matrix elements of the hamilton operator which were neglected in the original presentation of the model by Nilsson. This end is achieved by introduction of suitable deformation dependent coordinates first suggested by Nilsson; thus a new meaning is given to the deformation parameters δ,ω_0,η. With this new definition of the parameters, the old tables may be used to obtain slightly different energy levels and wave functions. (auth)

12525 NUCLEON TRANSFER REACTIONS ACCOMPANIED BY THE FORMATION OF A COMPOUND SYSTEM OF COMPLEX NUCLEI. E. Lozynski (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 64: 321-35 (Apr. 1965).

An experimental study of the dependence of the angular distributions for the (p + n) pick-up and (p + 3n) stripping reactions on the energy of ^{22}Ne ions was made. The measurements were performed for 0-180° and 90-140 Mev (laboratory system). The target was ^{197}Au, and a catcher-foil method was applied. The results obtained for the reaction ^{197}Au(^{22}Ne,^{24}Na) emphasize the tunnelling mechanism for the deuteron transfer into the incident nucleus. The contribution of the grazing process of the (p + n) transfer is found to be much smaller. The behavior of the total cross section for the generation of ^{24}Na at energies near the Coulomb barrier is found to be close to that of the excitation function of single neutron transfers, in agreement with the case of transfer of an associated (p + n) group. The energy dependence of the angular distribution of final products in the reaction ^{197}Au(^{22}Ne,^{18}F) shows that, in the stripping of (p + 3n) from the ^{22}Ne nucleus, the prevalent reaction mechanism is the transfer of nucleons in grazing collisions. In this case the degree of association in the transfer process seems to be low. In the range of angles 90-180° for the obtained angular distribution of the differential cross section for the (p + 3n) stripping and (p + n) pick-up reactions several maxima are observed, the number and position of which change with the incident particle energy. It is proposed that the observed effects are connected with formation of a very short-lived compound system of the interacting nuclei. On the basis of the performed analysis of the measured angular distributions, the conclusion was drawn that the compound system of two nuclei (in the investigated case) has an angular momentum of about 15 $\hbar$. (auth)

12526 THE TOTAL NEUTRON CROSS SECTION OF O^{18} FROM 0.14 TO 2.47 Mev. F. J. Vaughn, H. A. Grench, W. L. Imhof, J. H. Rowland, and M. Walt (Lockheed Missiles and Space Co., Palo Alto, Calif.). Nucl. Phys., 64: 336-42(Apr. 1965).

The total neutron cross section of ^{18}O was measured from 0.14 to 2.47 Mev by a transmission experiment. The neutrons were produced using the ^{7}Li(p,n)^{7}Be or the T(p,n)^{3}He reaction, the bombarding protons being obtained from a 3.5 Mev Van de Graaff accelerator. The scattering samples consisted of water enriched to 97% in ^{18}O enclosed in thin-walled stainless steel cylinders 1 and 2 cm long. Prominent resonances were observed at neutron energies of 0.661, 1.192, 1.256, 1.840, and 2.445 Mev. Peak height analysis yielded J values of $^3/_2$, $^1/_2$, $^3/_2$, $^3/_2$, and $\geq {}^5/_2$, respectively, for these resonances. In addition a broad maximum centred at a neutron energy of 1.56 Mev and indications of resonance structure in the energy region from about 2.25 to 2.40 Mev were observed. (auth)

12527 THE TOTAL NEUTRON CROSS SECTION OF O^{18} FROM 2.45 TO 19.0 Mev. S. R. Salisbury, D. B. Fossan, and F. J. Vaughn (Lockheed Missiles and Space Co., Palo Alto, Calif.). Nucl. Phys., 64: 343-8(Apr. 1965).

The total neutron cross section of ^{18}O was measured from 2.45 to 8.50 Mev and from 10.6 to 19.0 Mev by a transmission experiment. The neutrons were produced using the D(d,n) ^{3}He, ^{9}Be(α,n)^{12}C, ^{15}N(d,n)^{16}O, and T(d,n)^{4}He reactions in the appropriate energy intervals. The scattering sample consisted of water enriched to 97% in ^{18}O enclosed in thin-walled stainless steel cylinders with a total length of 3 cm. In the energy range up to 8.50 Mev measurements were made with an energy resolution of 35-60 kev; considerable resonance structure was observed. The cross section in the higher energy region, observed with an energy resolution of 100-300 kev, was found to be a more slowly-varying function of energy. (auth)

12528 VARIATIONAL TREATMENT OF REARRANGEMENT COLLISIONS. C. Joachain (Université Libre, Brussels). Nucl. Phys., 64: 548-66(Apr. 1965).

Variational principles based on the formal theory of scattering and generalizing Schwinger's method for direct collisions are proposed for the treatment of binary rearrangement collisions. These principles are established both for free and coupled waves, and are compared with the Born development. Application is made to three-body problems, the case of nuclear pick-up and stripping reactions being examined in detail in a specific example. (auth)

12529 STUDY OF π-NUCLEI SCATTERING BELOW 500 AND 1300 Mev. M. Crozon, Ph. Chavanon, A. Courau, Th. Leray, J. L. Narjoux, and J. Tocqueville (Collège de France, Paris). Nucl. Phys., 64: 567-84(Apr. 1965). (In French)

The total elastic (σ_{el}) and inelastic (σ_a) cross sections for reactions of π-mesons with Be, C, and Al nuclei at various energies around 1 Bev were measured. The counter experiment, made with the help of Saclay's proton synchrotron, was a poor and rich geometry one. The extrapolation to zero angle of the attenuation of the beam measurements at different angles was made with the use of the optical model. It is assumed that the shape of the nuclei is the one determined by electron scattering experiments, and that the inelastic products have an approximately constant distribution. From this use of the optical model one can get not only σ_a and σ_{el}, but also a value of the mean forward scattering amplitude $\overline{f(0)}$ of the π-nucleon system for linked nucleons. This value has to be compared to the mean π-free nucleon amplitude at the same energy of the pion, in order to check the usual approximations used in the optical model. The order of magnitude of the two amplitudes is the same and, in particular, the real parts are not significantly different, as could be deduced from other experiments. To get a fair agreement between the imaginary parts, one has to take account of the Fermi momenta of nucleons and of second order corrections using correlation functions of nucleons inside nuclei. (auth)

12530 THE p-SHELL HYPERNUCLEI AND THE Λ-N INTERACTION. A. R. Bodmer (Univ. of Manchester, Eng. and Argonne National Lab., Ill.) and J. W. Murphy. Nucl. Phys., 64: 593-628(Apr. 1965).

The p shell hypernuclei were studied in detail using two and three-body central Yukawa Λ-N interactions. Intermediate coupled wave functions and a range of density distributions are considered for the core nuclei. The Λ wave

function and volume integrals are obtained by numerical solution of the appropriate two-body (Λ-core nucleus) eigenvalue problems; the results being most conveniently represented by the corresponding numerical values of the relevant Slater integrals and the Λ kinetic energies. The simple assumption of a spin-dependent and the charge-dependent two-body interaction turns out to be adequate to account for all the known B_Λ. In particular, the values of the spin-averaged volume integral of the two-body interaction, which are obtained from $_\Lambda He^5$, $_\Lambda Be^9$, and $_\Lambda C^{13}$, agree very well in the absence of three-body forces. Further, quite small upper limits on the permissible strength of the latter are obtained. Almost nothing can be deduced about the range of the two-body forces or about their interactions in relative p states. The implications of the results for the well depth in nuclear matter are discussed. The spin-dependent interaction energy is found to be completely masked by quite small uncertainties in the core sizes and, to a lesser extent, by uncertainties in the re-arrangement energies. Effectively nothing can at present be deduced from the p shell hypernuclei about the spin dependence which with most plausible assumptions about the core sizes and re-arrangement energies can be made to agree with the values obtained from the s shell hypernuclei. Conversely assuming such values for the spin dependence can make the Λ into a quite sensitive probe into small size differences. (auth)

12531 SCATTERING OF PIONS FROM H_3 AND He_3. G. Ramachandran and K. Ananthanarayanan (MATSCIENCE, Madras). Nucl. Phys., 64: 652-6(Apr. 1965).

The scattering of pions from the three-nucleon systems ^3H and ^3He is studied taking into consideration the admixture of the S state of mixed symmetry. It is found that the differential cross section is most sensitive to the percentage admixture of this state at around 90°. (auth)

12532 ELASTIC MAGNETIC ELECTRON SCATTERING. R. H. Pratt and J. D. Walecka (Stanford Univ., Calif.). Nucl. Phys., 64: 677-84(Apr. 1965).

The 180° elastic scattering of electrons from nuclei, as in the recent experiments of Goldemberg and Torizuka is discussed in the Born approximation and the corrections expected to arise from a static magnetic moment are indicated. (auth)

12533 NUCLEAR STRUCTURE OF Hg^{200}. Mitsuo Sakai, Hidetsugu Ikegami, Toshimitsu Yamazaki, and Kazuo Saito (Tokyo Univ.). Nucl. Phys., 65: 177-202 (May 1965).

The decay of ^{200}Tl was investigated by the use of sector-type double-focusing beta spectrometers for the measurements of the conversion spectrum and by means of gamma-gamma and electron-gamma coincidence and directional correlation measurements; 86 electron lines were observed and 63 gamma rays were identified as belonging to ^{200}Hg. Eleven new levels were proposed at 1028.6 (2^+), 1254.6 (2^+), 1643.2, 1846, 1970 (1^+), 2085 (1^+), 2112, 2267, 2286, 2358, 2380 (1^+) kev besides the known 368.0 (2^+), 947.4 (4^+), 1574.8 (2^+), 1595.0 (1^+), 1733.0 (3^+), 1776 (3^+), and 1885 (2^+) kev levels. The spin and parity of the 947.4 kev level were uniquely determined as 4^+ by electron-gamma directional correlation measurements, and the 1028.6 kev level is probably the 2^+ member of the two-phonon triplet. The discovery of this level revealed a close analogy with the level scheme of ^{198}Hg. (auth)

12534 BINDING ENERGIES OF NUCLEAR TWO, THREE AND FOUR-BODY SYSTEMS. Y. C. Tang*, E. W. Schmid, and R. C. Herndon (*Brookhaven National Lab., Upton, N. Y.). Nucl. Phys., 65: 203-24(May 1965). (BNL-8293)

The binding energies of the nuclear three- and four-body problems are calculated using a variational method with hard-core central potentials of various core radii which fit the two-nucleon low-energy scattering data. Both the upper and the lower bounds are computed. The results show that when the core radius has a value between 0.35 and 0.55 f, reasonable agreement with experimental data on the binding energies and rms radii of the triton and the alpha particle and the Coulomb energy of ^3He can be obtained. (auth)

12535 THE Ar^{40} THERMAL ACTIVATION CROSS-SECTION AND RESONANCE INTEGRAL. R. L. D. French and B. Bradley (United Kingdom Atomic Energy Authority, Sellafield, Cumb., Eng.). Nucl. Phys., 65: 225-35(May 1965).

The $^{40}Ar(n,\gamma)^{41}Ar$ thermal neutron activation cross section was determined to be 0.723 ± 0.025 b, utilizing both Au (σ_0 = 98.4 ± 0.5) and Co (σ_0 = 37.7 ± 0.7 b) as reference standards. This value is 26% higher than the normally accepted activation cross section of 0.53 b and is 14% higher than the weighted mean elemental absorption cross section of 0.62 b. The resonance capture integral above 0.5 ev, which was not previously measured, was found to be 0.41 ± 0.03 b relative to 1534 b for ^{197}Au. The Westcott temperature-independent resonance parameter s_0 was found to be 0.217 ± 0.010. (auth)

12536 NEUTRON SHELL EFFECTS IN THE (n,2n) CROSS-SECTIONS AT 14 Mev. M. Bormann (Inst. for Experimental Physics, Hamburg). Nucl. Phys., 65: 257-74(May 1965).

The systematics of the available total (n,2n) reaction cross sections for 14 Mev neutrons were investigated for even-neutron target nuclei. The existence of neutron shell effects is verified and discussed on the basis of the statistical theory. Minima in the (n,2n) cross sections at the magic neutron numbers N = 28 and 50 for even- and N = 20 for odd-proton target nuclei can be accounted for by similar trends in the Q values. Cross-section maxima at the closed neutron shells N = 82 and 126 for even- and N = 28, 50, 82, and 126 for odd-proton target nuclei can be understood as an effect of shell closure on the nuclear level density, the relative decrease of which on passing across a closed shell is larger for higher excitation energies. The (n,n'γ) reaction is the principal one competing with the (n,2n) process at 14 Mev in the medium and heavy mass regions. Since for the (n,n'γ) reaction the residual excitation energy lies in the region up to 12 Mev, whereas for the (n,2n) reaction it does not exceed 4 Mev, and since the relative change in the level density is greater at the higher excitation energies, the competition between (n,n'γ) and (n,2n) reactions favors the latter in the region of closed neutron shells and thus accounts for the observed maxima in the (n,2n) cross-section systematics. 96 references. (auth)

12537 THE REACTION Al^{27}(p,ALPHA)Mg^{24}. G. P. Lawrence and A. R. Quinton (Australian National Univ., Canberra). Nucl. Phys., 65: 275-88(May 1965).

Excitation functions for the reaction $^{27}Al(p,\alpha)^{24}Mg$ populating the ground state and first five excited states of ^{24}Mg were measured in 25 kev steps, over the proton energy range 6.0–10.0 Mev, at lab angles of 90 and 135°. All show considerable complex structure and rapid variation with incident proton energy. Sets of closely spaced angular distributions were measured for several groups at median energies of 3.65, 6.00, and 8.725 Mev in order to provide additional information on the nature of the reaction mechanism. Most of the data appear to indicate that the $^{27}Al(p,\alpha)^{24}Mg$ reaction proceeds predominantly through a compound nucleus mechanism within the studied excitation range. (auth)

12538 A MEASUREMENT OF THE A PARAMETER IN PROTON-PROTON SCATTERING AT 47.5 Mev. A. Ashmore*, M. Devine, B. Hird, J. Litt, W. H. Range, M. E. Shepherd, and R. L. Clarke (*London Univ.). Nucl. Phys., 65: 305-17(May 1965).

The experiment was made at the Rutherford Laboratory on the Proton Linear Accelerator using the polarized proton source. Five high-pressure helium gas polarization analyzers were grouped around a liquid-hydrogen target. Results are given for Wolfenstein parameters at 5 angles from 23.5 to 87.1° cms. These values were used in phase-

shift analyses which show that solutions of type No. 2 can be excluded. The solutions of type No. 1 give a lower, more precise value of the $^3P_0$ phase shift. (auth)

12539 THE ANGULAR DISTRIBUTION OF THE PRODUCTS OF THE MULTINUCLEON TRANSFER REACTIONS. J. Grabowski, B. N. Kalinkin, and N. F. Markova (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 65: 294-304(May 1965).

The quasiclassical theory of multinucleon transfer reactions is given. It is shown that contrary to the case of one-nucleon transfer in these reactions it is necessary to take into account their inelastic character. (auth)

12540 ELASTIC SCATTERING OF 4-20 Mev ALPHA PARTICLES BY Be^9. R. B. Taylor, N. R. Fletcher, and R. H. Davis (Florida State Univ., Tallahassee). Nucl. Phys., 65: 318-28(May 1965).

The scattering of alpha particles by ^{9}Be was studied in the bombarding energy range 4-20 Mev. Eight excitation functions and sixteen angular distributions were measured. Angular distributions were analyzed with an optical model which included a term coupling the target spin I to the orbital angular momentum l. The optical model parameters varied smoothly with energy over the entire range, and the value of the spin-orbit parameter V_{so} varied from 1.6 to 2.7 Mev. Real well depths of about 55 Mev were used. Optical model fits without the I·l term were poor especially at back angles. A smooth cut-off model analysis was also attempted with little success. (auth)

12541 DIRECT RADIATIVE CAPTURE INTO A RESONANT STATE. A. Faessler (Universitat, Freiburg i. B.) Nucl. Phys., 65: 329-36(May 1965).

A theory of direct radiative capture into a resonant final state is given. The part which results from the interaction with the Coulomb potential can be neglected compared with that from the nuclear potential. The radial matrix element is essentially only a product of the depth of the nuclear potential and the Coulomb functions at the nuclear radius. A formula for the total cross section is derived. The theory is compared with experiment for the two reactions $^{12}C(p, \gamma p')^{12}C$ and $^{12}C(p,\gamma p')^{12}C$. The agreement between theory and experiment is satisfactory. (auth)

12542 THE DECAY ENERGY OF ^{203}Pb. W. H. G. Lewin, J. Lettinga, B. van Nooijen, and A. H. Wapstra (Laboratorium voor Technische Fysika, Delft, Holland). Nucl. Phys., 65: 337-43(May 1965).

The decay energy of ^{203}Pb was measured to be 963^{+65}_{-40} kev by means of coincidence experiments between x and gamma rays. The result agrees with the value 890^{+60}_{-30} kev measured by Hagedoorn and also with the value 943 ± 25 kev computed from known mass differences and from beta- and alpha-decay energies. The result disagrees with the value 817 ± 8 kev reported by Persson and Sujkowski. (auth)

12543 NUCLEAR RESONANT SCATTERING OF GAMMA-RAYS IN Pb, Ni AND Cd. M. Giannini, P. Oliva, D. Prosperi, and S. Sciuti (Centro di Studi Nucleari, Casaccia, Italy and CNEN, Rome). Nucl. Phys., 65: 344-52(May 1965).

Nuclear resonant scattering experiments were carried out using γ lines from thermal neutron radiative capture. Direct evidence of inelastic scattering processes was obtained in two cases (Ni and Cd). Effective cross sections for resonance processes at different temperatures were measured for all the examined cases. The level widths for the ground state transition and the total widths were also derived for all cases. (auth)

12544 THE NEUTRON SPECTRUM IN THE VICINITY OF RESONANCES. Hans-Juergen Siegert (Technische Hochschule, Stuttgart). Nukleonik, 6: 307-10(Oct. 1964). (In German)

The neutron spectrum for a mixture of ^{238}U and carbon with 30 or 3000 barn potential scattering cross sections for absorber atoms for the ^{238}U resonance lines at 6.68, 21.0, and 36.8 ev was calculated. The neutron spectrum showed characteristic differences on the basis of the various scattering characteristics of the resonance lines. For poorer moderation the influence of interference scattering on the spectrum was important. The NR and NRIA approximations could not reproduce the flux spectrum. (tr-auth)

12545 ELASTIC SCATTERING AND PHOTON COUPLING IN THE COULOMB FIELD OF NUCLEUS IN HIGH FREQUENCY RANGE. S. S. Sannikov (Inst. of Physics and Tech., Khar'kov). Nukleonika, 9: 393-5(1964). (In Russian)

Elastic scattering is considered for angles larger than m/ω, where m is the electron mass and ω is the frequency of the incident photon. From a dispersion relation it follows that the integral elastic scattering cross section for large angles is $\sigma = (2\pi/5)(Z^4\alpha^6/\omega^2)\ln^5(\omega/m)$, where α is the fine-structure constant. For $\omega \sim me^{5}$ and $Z \sim 40$, $\sigma \sim 10^{-28}$ cm^2. The combination of two photons at high frequency is considered in the case where the paths of the incident photons are parallel. The amplitude of the combination cross section follows from the dispersion relation as the formation of an electron-positron pair followed by the annihilation of the pair as one photon which leaves at an angle θ with respect to the incident photons. By integrating $dR/d\theta$ over all angles the total probability for a combination $R = 0.05\ Z^2r_0^5m/\omega$ for $\omega_1 = \omega_2 = \omega_3/2$, where r_0 is the classical electron radius, was found. For a combination in an electron field R is proportional to r_0^5m/ω_3 for all $\omega_1 \gg m$. For $\omega_1 \ll m$, $dR = (Z^2r_0^5/300\pi)(\omega_1\omega_2\omega_3/m_3)(\sin^2\theta d\theta)$. Here the indices 1 and 2 refer to the incident photons and 3 refers to the emitted photon. Combination in the electron field is important only at small frequencies. (TTT)

12546 PREMELTING ANOMALIES IN THE MÖSSBAUER EFFECT IN TIN. G. Longworth and R. H. Packwood (Univ. of Birmingham, Eng.). Phys. Letters, 14: 75-6(Jan. 15, 1965).

The resonance absorption of γ rays in pure and impure ^{119}Sn was measured over the melting region, 10 to 0.05°C. A gradual decrease in the absorption was observed over the last 3°C, which confirm previous results that the premelting anomaly in the Mössbauer effect is directly related to the presence of alloying additions in absorbers. (L.B.S.)

12547 ON THE SIGN OF CHANGE OF THE CHARGE RADIUS OF THE Sn^{119} NUCLEUS IN THE TRANSITION TO THE 23.8 kev LEVEL. V. I. Goldanskii and E. F. Makarov (Inst. of Chemical Physics, Moscow). Phys. Letters, 14: 111-12(Jan. 15, 1965).

Taking into account the action of increasing bond ionity on the effective radius of a valent shell and the contribution from inner S-shells to the magnitude of $|\psi(o)|^2$, which was neglected in previous considerations leading to the conclusion that the charge radius of the ^{119}Sn nucleus increases in the transition to the 23.8-kev level ($\Delta R/R > O$), a new interpretation of Mössbauer chemical shift and NQR data results in a change of sign of $\Delta R/R$. (L.B.S.)

12548 CONFIGURATION MIXING IN THE GROUND STATE OF Ca^{40}. C. Glashausser, M. Kondo, M. E. Rickey, and E. Rost (Univ. of Colorado, Boulder). Phys. Letters, 14: 113-15(Jan. 15, 1965).

It is shown that the 2.80-Mev state of ^{39}Ca is a $1f_{7/2}$ state by virtue of its relatively strong excitation and characteristic angular distributions in the $^{40}Ca(p,d)^{39}Ca$ and $^{40}Ca(^3He, ^4He)^{39}Ca$ reactions at 27.3 Mev and 30 Mev, respectively. The typical spectra and angular distributions are shown for these reactions and also the 7.30-Mev analog states of the $^{48}Ti(p,d)^{47}Ti$ and $^{48}Ti(^3He,^4He)^{47}Ti$ reactions. Experimental curves are compared with DWBA predictions, and spectroscopic factors for the $d_{3/2}$ hole state and $^7/_2^-$ neutron configuration are determined. (L.B.S.)

12549 INELASTIC SCATTERING OF 50.9-Mev ALPHA PARTICLES FROM Ca^{40}. A. Springer and B. G. Harvey (Univ. of California, Berkeley). Phys. Letters, 14: 116-18(Jan. 15, 1965).

A model developed by Austern and Blair is used to analyze data on the inelastic scattering of 50.9-Mev alpha particles from a natural Calcium (97% ^{40}Ca) target to obtain information concerning spins, parities, and reduced transition probabilities of twelve excited states in ^{40}Ca. The model describes the inelastic scattering in the first order of the nuclear deformation as an adiabatic process and gives the inelastic scattering amplitude for a transition from a 0^+ state to a state of spin I and z-projection M_I. (L.B.S.)

12550 NUCLEAR STRUCTURE CALCULATIONS FOR ALPHA-SCATTERING. Daphne F. Jackson (Battersea Coll. of Tech., London). Phys. Letters, 14: 118-20 (Jan. 15, 1965).

A consistent method for calculating the optical potential and effective interaction for inelastic alpha scattering is presented. Preliminary results indicate that the calculation of deformation parameters is successful when the nuclear wave functions are correctly chosen, and thus information on nuclear structure can be obtained by this method. (L.B.S.)

12551 NOTE ON NUCLEAR RESONANCE FLUORESCENCE. E. Friedland (Univ. of Pretoria). Phys. Letters, 14: 120-1 (Jan. 15, 1965).

The differential cross section for resonance excitation by a Doppler-broadend γ emission line and subsequent deexcitation is given. It is pointed out that the conclusion reached by Hauser that the resonance effect is a function of $\Gamma_0\Gamma_i/\Gamma$ is incorrect; and that the effect is completely independent of Γ_i. It is also shown that the ratio of the resonant effects for transitions to intermediate and ground states is proportional to the third power of E_i/E_0. (L.B.S.)

12552 THE LEVEL DENSITIES IN THE COMPOUND NUCLEI Al^{27} AND Ar^{38} AT 20 Mev EXCITATION ENERGY. A. Richter, W. Von Witsch, P. Von Brentano, O. Haeusser, and T. Mayer-Kuckuk (Max Planck Institut für Kernphysik, Heidelberg). Phys. Letters, 14: 121-3 (Jan. 15, 1965).

An argument based on fits of the average angular distributions by a Hauser–Feshbach expression is presented in support of the conclusion that the reaction mechanism for $^{26}Mg(p,\alpha)^{23}Na$ and $^{37}Cl(p,\alpha)^{34}S$ at 20 Mev energy is essentially of a statistical nature. The analysis also leads to an estimate of the level density of the compound nuclei ^{27}Al and ^{38}Ar in the continuum region. (L.B.S.)

12553 IDENTIFICATION OF NUCLEAR LEVELS APPEARING IN THE CAPTURE OF s AND p NEUTRONS. H. V. Muradyan (Kurchatov Atomic Energy Inst., Moscow). Phys. Letters, 14: 123-5 (Jan. 15, 1965).

A method is proposed by which interferences between resonant and potential scattering can be detected for the identification of nuclear levels in s and p neutron capture, and which also permits orbital momentum assignments to these levels. The arrangement employs a moving sample in transmission measurements, the neutrons transmitted by the moving sample are registered by a self-indication technique. Results of ^{91}Zr and ^{56}Fe measurements by this method are presented. (L.B.S.)

12554 A REGGE TRAJECTORY FOR ENERGY LEVELS IN Be^8. P. B. Treacy (Australian National Univ., Canberra). Phys. Letters, 14: 125-7 (Jan. 15, 1965).

A single Regge trajectory is defined for low levels in ^{8}Be and the form of the scattering amplitude is given. Partial wave amplitudes illustrating the resonance behavior were obtained from Legendre functions and the first three widths and levels were found. The resulting trajectory is shown. (L.B.S.)

12555 $Ca^{40}(\alpha,\alpha')$: A TEST OF PARTICLE-HOLE CALCULATIONS. R. W. Bauer, A. M. Bernstein, G. Heymann, E. P. Lippincott, and N. S. Wall (Massachusetts Inst. of Tech., Cambridge). Phys. Letters, 14: 129-33 (Jan. 15, 1965). (MIT-2098-101)

A description is given of an experiment on 30.5-Mev α scattering from ^{40}Ca at the MIT cyclotron. The energy spectrum at 31° (lab) is presented. Differential cross sections were obtained for 14 states, including the ground state. Angular distributions are presented, and α-values, spins, and parities are tabulated. The results are compared to the predictions of Gillet and the application of Gillet's wave function to inelastic α scattering by Sanderson and Wall. (L.B.S.)

12556 A NEW SHORT-LIVED ISOTOPE OF GALLIUM. M. Nurmia and R. W. Fink (Argonne National Lab., Ill.). Phys. Letters, 14: 136-7 (Jan. 15, 1965).

A new isotope of Ga was found in a study of $^{58}Ni(^6Li,n)$ and $^{60}Ni(^6Li,3n)$ reactions at 66 Mev, and in the $^{63}Cu(\alpha,4n)$ at 42 Mev. It was identified by radiochemical separation as ^{63}Ga, with a half life of 33 ± 4 sec. (L.B.S.)

12557 CORRECTED Na^{20} MASS AND LEVELS IN Na^{20} AND F^{16} USING THE (He^3,t) REACTION. R. H. Pehl and J. Cerny (Univ. of California, Berkeley). Phys. Letters, 14: 137-9 (Jan. 15, 1965).

The energy spectra from the $^{16}O(^3He,t)^{16}F$ and $^{20}Ne(^3He,t)^{20}Na$ reactions were measured using 40.2-Mev ^{3}He beams from the Berkeley 88-inch cyclotron, and the observed levels are tabulated, J^π assignments to the low-lying levels of ^{16}F are compared with results of a recent study of the $^{14}N(^3He,n)^{16}F$, and it is argued that the 1^- and 2^- states should be reversed. The Q-value for the $^{20}Ne(^3He,t)^{20}Na$ reaction was found to be 14.04 ± 0.5 Mev, which corresponds to a mass excess of 6.98 Mev for ^{20}Na. (L.B.S.)

12558 LONGITUDINAL DISPERSIVE CORRECTIONS TO ELASTIC SCATTERING OF HIGH ENERGY ELECTRONS ON O^{16}. G. R. Bishop (Glasgow Univ.), A. Bottino, G. Ciocchetti, and A. Molinari. Phys. Letters, 14: 140-1 (Jan. 15, 1965).

Results of calculations of the ratio between the dispersive and static corrections as a function of the scattering angle are reported for electron scattering on ^{16}O at 420 Mev/G. The ratio was found to be a slowly varying function of the momentum transfer. It is pointed out that the conclusion that the static contribution is dominant is valid for ^{16}O, but could be modified in the case of the excitation of a nucleus with a different inelastic spectrum, e.g. with strong electric quadrupole transitions. (L.B.S.)

12559 ODD PARITY EXCITATIONS OF O^{16} WITH A REALISTIC NUCLEON-NUCLEON INTERACTION. A. M. Green (Inst. for Advanced Study, Princeton, N. J.), A. Kallio, and K. Kolltveit. Phys. Letters, 14: 142-4 (Jan. 15, 1965).

The odd parity states were investigated using a nucleon-nucleon potential which includes noncentral parameters and acting not only in relative s-states. The Moszkowski-Scott separation method is applied for calculating the matrix elements in relative coordinates, using Wong's values where possible. The Talmi integrals for the Gammel-Thaler potential are tabulated, and results for the calculation of odd-parity states in ^{16}O in the random phase approximation are displayed in diagrams. (L.B.S.)

12560 EFFECTIVE INTERACTION IN C^{14}. Y. R. Waghmare and C. K. Majumdat (Univ. of California, San Diego, La Jolla). Phys. Letters, 14: 144-6 (Jan. 15, 1965).

An attempt was made to estimate the discrepancy of ~ 2.0 Mev in the ground state of ^{14}C on the basis of an analysis of $P_{1/2}$ doublet splittings. The energy gap for a closed shell nucleus was investigated using a two-body potential, and calculations of the energy gap and chemical potential were made using $p_{3/2}$, $p_{1/2}$, $d_{5/2}$, $s_{1/2}$, and $d_{3/2}$ single particle energies. Large fluctuations of the energy gap were observed over the particle number range $N \pm \sqrt{N}$. Random phase approximation correction was found to be < 0.5 Mev for the $1^- - 0^+$ level splitting in ^{14}C. (L.B.S.)

12561 ENERGY GAP IN A CUBICAL MODEL FOR NUCLEI. C. J. Thompson (Univ. of California, San Diego, La Jolla). Phys. Letters, 14: 146-9 (Jan. 15, 1965).

Equations for determining the energy gap and chemical potential for a simple finite model for nuclei were derived and solved numerically by a computer for the case of pro-

tons. The chemical potential and the energy gap are shown as functions of the size of the nucleus. The results contain oscillations which agree favorably with experiment. (L.B.S.)

12562 HYPERFINE STRUCTURE OF Lu^{176m} BY THE METHOD OF ATOMIC BEAMS. M. B. White (Univ. of California, Berkeley), S. S. Alpert, S. Penselin, T. I. Moran, V. W. Cohen, and E. Lipworth. Phys. Rev., 137: B477-82 (Feb. 8, 1965). (BNL-8446).

The hyperfine structure interaction constants of 3.7-h ^{176m}Lu in the $^2D_{\frac{5}{2}}$ and $^2D_{\frac{3}{2}}$ electronic states were measured using the atomic beam magnetic resonance technique. The nuclear spin was found to be 1. After correcting for the mutual perturbations between the two electronic states, the constants for the $^2D_{\frac{5}{2}}$ state were found to be A = 97,196,440 (300) cps and B = −635,193,140(700) cps, while for the $^2D_{\frac{3}{2}}$ state, A = 73,172,850(300) cps and B = −781,974,690(700) cps. These lead to values of μ = 0.318(3) nm and Q = −2.39 (4) b for the nuclear moments. The values of g_j are 0.79931 (5) for the $^2D_{\frac{5}{2}}$, and 1.20040(16) for the $^2D_{\frac{3}{2}}$ state. Comparing the ratio $A_{\frac{5}{2}}/A_{\frac{3}{2}}$ in ^{176}Lu and in ^{176m}Lu, one finds a difference in the hyperfine structure anomalies. The ratio $B_{\frac{5}{2}}/B_{\frac{3}{2}}$ is the same for the two isotopes within the precision of the presently available data in ^{176}Lu. (auth)

12563 EXCITED STATES OF $_{56}Ba^{135}$ FROM THE DECAY OF $_{57}La^{135}$ (19.8 h). H. A. Grench and S. B. Burson (Argonne National Lab., Ill.). Phys. Rev., 137: B483-6 (Feb. 8, 1965).

The decay of ^{135}La was studied by scintillation coincidence spectroscopy. The previously suggested decay scheme is largely verified. Levels in ^{135}Ba at 218, 268, 481, 587, and 860 kev are indicated. Previously unreported transitions between the 860- and 481-kev levels and between the 481- and 218-kev levels were found. A lower limit of 5000 is placed on the K/β^+ ratio to the ground state of ^{135}Ba. Spin and parity assignments are made to the ground state of ^{135}La and to excited states of ^{135}Ba. (auth)

12564 EFFECTIVE INTERACTION IN NUCLEAR SYSTEMS. Daniel S. Koltun (Univ. of Rochester, N. Y.). Phys. Rev., 137: B487-92(Feb. 8, 1965).

An effective interaction is defined within the two-body correlation theory of Brueckner, Goldstone, and Bethe. A model nuclear system with nonuniform density is considered for the purpose of examining the local density dependence approximation for the effective interaction, as proposed by Brueckner, Gammel, and Weitzner. It is shown for an infinite nuclear system with a small-amplitude, long-wavelength, periodic density variation, that the local density approximation disagrees with the self-consistent treatment. The magnitude of the disagreement is estimated to be of the same order as the density dependence itself. Some improvements are suggested. (auth)

12565 RADIATIVE CAPTURE OF He^3 BY Li^7. P. Paul, S. L. Blatt, and D. Kohler (Stanford Univ., Calif.). Phys. Rev., 137: B493-8(Feb. 8, 1965).

A system suitable for detection of high-energy gamma rays produced with low cross sections in the presence of high background counting rate is described. It is applied to a study of radiative capture of ^{3}He by ^{7}Li for bombarding energies up to 3.0 Mev. Gamma transitions to the first six states in ^{10}B are observed and their energy dependence is measured. The excitation functions at 90° show peaks at 1.1 and 2.2 Mev for the transitions to the ground state and the one at 4.77 Mev, with c.m. widths of less than 500 and 420 kev, respectively. Transitions to the first and fourth excited states show a broad maximum around 1.4 Mev with a c.m. width of less than 600 kev. The cross section for the decay to 4.77 Mev is largest, with $d\sigma/d\Omega$ reaching 5 μb/sr at the 2.2-Mev peak. At some excitation energies asymmetries $Y(0°)/Y(90°)$ are obtained which indicate strong interferences. The peaks are interpreted as resonances and lower limits on $(2J+1)\Gamma_\gamma$ are presented. (auth)

12566 SEARCH FOR RESONANCES IN THE REACTION $Li^7(He^3,\alpha)Li^6$. P. Paul, S. L. Blatt, and D. Kohler (Stanford Univ., Calif.). Phys. Rev., 137: B499-501(Feb. 8, 1965).

Angular distributions and cross sections for the reaction ^{7}Li(^{3}He,α)^{6}Li leading to the ground state and the first two excited states of ^{6}Li were measured in the energy range 0.8 to 3.0 Mev. The data are discussed with regard to resonances previously observed in the radiative capture of ^{3}He by ^{7}Li. Some indication of these resonances is seen. Their alpha-particle widths are apparently small compared to their total widths. (auth)

12567 COLLECTIVE NUCLEAR VIBRATIONS INDUCED BY HIGH-ENERGY NEUTRINOS. H. Ueberall (Catholic Univ. of America, Washington, D. C.). Phys. Rev., 137: B502-7(Feb. 8, 1965).

Neutrino absorption in nuclei leading to states of collective vibration (giant dipole) is investigated. The collective states are described schematically by using the Goldhaber-Teller model and its generalization to spin-isobaric spin vibrations. (auth)

12568 QUADRUPOLE-DIPOLE MIXTURE OF THE N^{14} 3.95 → 0 GAMMA-RAY TRANSITION. F. Riess (Universitat, Freiburg i. B.), W. Trost, H. J. Rose, and E. K. Warburton. Phys. Rev., 137: B507-10(Feb. 8, 1965).

The quadrupole-dipole mixing ratio of the 4% gamma-ray branch from the ^{14}N second excited state at 3.95 Mev to the ground state was determined using the ^{12}C(^{3}He,p)^{14}N reaction and an ^{3}He beam of 5 Mev. Gamma rays due to the decay of the 3.95-Mev level were detected in coincidence with protons of the right energy to populate the 3.95-Mev level. The protons were detected in a surface-barrier counter at 0° with respect to the ^{3}He beam, and the populations of the magnetic substates were fixed from a simultaneous observation of the transition to the 0^+, 2.31-Mev level. Two regions of values for the mixing ratio x consistent with the experiment were found, namely, $-0.5 \leq x \leq -0.2$ and $-5 \leq x \leq -2$. (auth)

12569 KINETIC-ENERGY DISTRIBUTIONS AND THE CORRELATION OF ANISOTROPY AND ASYMMETRY IN THE 4-Mev NEUTRON-INDUCED FISSION OF U^{235}. S. S. Kapoor, D. M. Nadkarni, R. Ramanna, and P. N. Rama Rao (Atomic Energy Establishment, Trombay, India). Phys. Rev., 137: B511-18(Feb. 8, 1965).

The kinetic-energy distributions and the correlation of the angular anisotropy and the mass asymmetry of the fission fragments were determined in the fission of ^{235}U induced by 4-Mev neutrons. The kinetic energies of the pair of fragments emitted parallel and perpendicular to the incident beam direction are measured by solid-state detectors and recorded by a three-dimensional analog-to-digital converter incorporating a printout arrangement. The observed variation of the total kinetic energy $\bar{E}_k$ and the mean-square deviation σ_{Ek}^2 are found to be different from that observed for the case of thermal fission. For the near-symmetric fragments the total-kinetic-energy distributions show a small peak at an energy of about 125 Mev in addition to the main peak at 163 Mev. The anisotropy was found to increase with the asymmetry in the region of mass ratios 1.2 to 1.7. The different possibilities leading to the observed dependence of the anisotropy on the asymmetry are discussed. (auth)

12570 RELATIVE PROBABILITY OF TERNARY FISSION WITH EMISSION OF LONG-RANGE ALPHA PARTICLES IN THE THERMAL-NEUTRON FISSION OF U^{235}. I. G. Schroeder, A. J. Deruytter, and J. A. Moore (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B519-23(Feb. 8, 1965).

The ratio of binary to ternary fission in ^{235}U was measured using solid-state detectors and aluminum absorbers, for two reactor beams, having cadmium ratios of 30 to 1 and 200 to 1, and for incident neutron energies of 0.003, 0.0253, 0.08, and 0.3 ev. Furthermore, a new method of measuring this ratio without the use of absorbers is presented. The results obtained show that the binary-to-ternary fission ratio in ^{235}U is a constant to a precision of 3% in the energy region between 0.003 and 0.3 ev. The measurements performed with the two reactor beams, having cadmium ratios of 30 to 1 and 200 to 1, gave for

this ratio 518 ± 13 and 512 ± 14, respectively. The measurement performed without an absorber gave a value of 490 ± 20 for the 30-to-1 cadmium-ratio beam. It is concluded that the binary-to-ternary fission ratio in ^{235}U is a constant in the energy region considered to within the precision of the experiment. (auth)

12571 COULOMB DISINTEGRATION OF ^{6}Li. J. M. Hansteen and H. W. Wittern (Florida State Univ., Tallahassee). Phys. Rev., 137: B524-34(Feb. 8, 1965).

The disintegration of ^{6}Li projectiles into alpha particles and deuterons in the Coulomb field of a heavy target nucleus is studied theoretically by use of refined cluster model wave functions. Transitions to the assumed ^{3}D states in ^{6}Li, followed by alpha-deuteron breakup, as well as transitions to the alpha-deuteron continuum, are considered. A semiclassical, first-order time-dependent perturbation treatment is used. A very good agreement with measurements of the total breakup cross section with a gold target is obtained for bombarding energies below the Coulomb barrier. The long-range term in the relative-motion part of the cluster wave function is shown to be decisive for the magnitude of the breakup probability. No fitting of the nuclear model parameters is performed. The quadrupole transitions to the 3^{+} state at 2.18 Mev are found to be dominating for sub-barrier energies. The theoretical value of the reduced matrix element for excitations to this state is calculated to be $B(E2; 1 \rightarrow 3) = 85 \times 10^{-52} e^2$ cm^4. This value is about 20 times the single-particle estimate, but is consistent with the alpha-deuteron disintegration experiments. This large number is interpreted as originating from the large diffuseness of the ^{6}Li nucleus. (auth)

12572 NEUTRON RESONANCE SPECTROSCOPY. V. Nb, Ag, I, AND Cs. J. B. Garg, J. Rainwater, and W. W. Havens, Jr. (Columbia Univ., New York). Phys. Rev., 137: B547-75(Feb. 8, 1965).

Total neutron cross-section measurements for niobium, natural silver, iodine, and cesium were made using a neutron velocity spectrometer with a resolution of about 0.5 nsec/m near the highest energy. The measurements were performed in the energy interval of 35 ev to 8 kev for niobium and 100 ev to about 4 kev for the other elements. The energies and neutron widths of about one thousand levels observed in these nuclei were determined. The level-spacing distributions of these nuclei were investigated and found to be compatible with the random-matrix model of Wigner. These elements have A values in the neighborhood of an expected peak in the p-wave strength function and relative minimum in the s-wave strength function. Histograms of the distribution of values for $y = \langle g\Gamma_n^0 \rangle^{1/2}$ show a considerable excess of small widths over the number expected from the Porter-Thomas $\nu = 1$ distribution. This excess is interpreted as being due to the observation of many p-wave levels. In the case of Nb, about ⅔ of the observed levels are probably p wave, while the percentages were much smaller for the other elements. The numerical values of the correlation coefficients between level spacings, neutron reduced widths, and local spacing were determined for all these nuclei. The correlation coefficients, except for the spacing correlation coefficients, are found to be consistent with zero within the statistical accuracy of the measurements. The $l = 0$ strength-function values averaged over spin states and isotopes of Nb, Ag, I, and Cs were determined as $(0.36 \pm 0.06) \times 10^{-4}$, $(0.48 \pm 0.04) \times 10^{-4}$, $(0.69 \pm 0.08) \times 10^{-4}$, and $(0.70 \pm 0.10) \times 10^{-4}$, respectively. (auth)

12573 TOTAL PHOTONUCLEAR CROSS SECTIONS FOR LOW ATOMIC NUMBER ELEMENTS. J. M. Wyckoff, B. Ziegler, H. W. Koch, and R. Uhlig (National Bureau of Standards, Washington, D. C.). Phys. Rev., 137: B576-94 (Feb. 8, 1965).

Total photonuclear cross sections were measured in an attenuation experiment using a scintillation pair spectrometer and an x-ray spectrum with a fixed maximum energy of 90 Mev. The cross sections as a function of x-ray photon energy for beryllium, carbon, oxygen, sodium, magnesium, aluminum, silicon, sulfur, calcium, nickel, cobalt, copper, and silver show detailed structure in many cases at x-ray energies of 15–30 Mev and display a consistent trend in shapes and magnitudes. The integrated cross sections up to 35 Mev relative to the classical dipole sum rule show a monotonic increase with atomic weight. Other analyses of the total photonuclear cross sections in terms of mean energies and of the ratios of the total cross sections to photoneutron cross sections are also presented. (auth)

12574 STUDY OF THE LOW-LYING LEVELS OF F^{18} BY MEANS OF THE $O^{16}(He^3,p\ gamma)F^{18}$ REACTION. A. R. Poletti and E. K. Warburton (Oxford Univ.) Phys. Rev., 137: B595-619(Feb. 8, 1965).

The particle-gamma angular-correlation method of Litherland and Ferguson was used to gain information on the decay modes and spin assignments of the first ten excited states of ^{18}F. The $^{16}O(^{3}He,p)^{18}F$ reaction was used with ^{3}He energies between 3.0 and 4.2 Mev. Protons were detected in an annular counter at 180° to the beam and gamma rays were detected at angles between 0 and 90° to the beam. Decay modes are given for all ten states of ^{18}F below 3.5-Mev excitation. Spin assignments of (0,1,2), 1, (1,2), 2, 1, and (2,3) were established for the levels at 1.08, 1.70, 2.10, 2.53, 3.13, and 3.35 Mev. The results combined with previous work lead to an assignment of 3^{+} for the 0.940-Mev level, a most probable assignment of 2 for the 3.06-Mev level, and 2^{+} for the 2.53-Mev level. Dipole-quadrupole or quadrupole-octupole mixing ratios were obtained for some of the gamma-ray transitions. The results are compared with previous shell-model predictions. (auth)

12575 POLARIZATION AND DIFFERENTIAL CROSS SECTIONS IN PROTON-PROTON AND PROTON-NUCLEUS SCATTERINGS AT 725 Mev. Paul G. McManigal, Richard D. Eandi, Selig N. Kaplan, and Burton J. Moyer (Univ. of California, Berkeley). Phys. Rev., 137: B620-9(Feb. 8, 1965). (UCRL-11496).

The polarization and angular distribution of protons scattered from protons, helium, beryllium, carbon, aluminum, calcium, iron, and tantalum were measured as functions of angle at 725 Mev. A variation of the usual double-elastic-scattering method was used, in that the sense of the first scattering angle was reversed in finding asymmetries, rather than the second angle. Energy analysis of the scattered beam was accomplished by means of a 102-degree magnetic spectrometer allowing a total resolution of ±10 Mev. The data were fitted with an optical model. In the proton-nucleus scattering the polarization reaches a maximum value of about 40% at angles less than the diffraction minimum. Results in proton-proton scatterings are more interesting; however, because of an uncertainty in the analyzing power of carbon, a definite statement cannot be made. One can say, however, that either the polarization in proton-proton scatterings is above 50% at this energy or the analyzing power of carbon at 6 deg and 600 Mev is more than 40%, which is considerably greater than the 30% measured at 725 Mev. (auth)

12576 SMALL-ANGLE ELASTIC SCATTERING OF FAST NEUTRONS AND THE ELECTRIC POLARIZABILITY OF THE NEUTRON. M. Walt and D. B. Fossan (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev., 137: B629-33(Feb. 8, 1965).

The differential cross section for elastic scattering of 0.57-Mev neutrons by uranium was measured at seven angles between 3.6 and 18° to a relative accuracy of about 4%. After subtraction of the Schwinger scattering contribution, the data show no evidence of enhanced small-angle scattering such as that previously observed at higher energies by Aleksandrov and by Dukarevich and Dyumin. The data are consistent with an electric polarizability α of the neutron of less than 2×10^{-40} cm^3. As this upper limit to α is smaller than the value needed to account for the anomalous small-angle scattering reported by Aleksandrov and by Dukarevich and Dyumin, it is concluded that the enhanced scattering is not produced by an electric polarizability of the neutron.

12577 MULTIPLE SCATTERING OF NEUTRONS IN VANADIUM AND COPPER. I. A. Blech and B. L. Averbach (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 137: A1113-16(Feb. 15, 1965).

The intensity of multiply scattered neutrons from cylindrical specimens of incoherent isotropic scatterers was calculated and compared with experimental values. The scattering is considered in terms of the number of scattering events, and the intensity is expressed in terms of the parameters μR, R/h, and σ_s/σ_t, where μ is the absorption coefficient, R is the radius, h is the height of the cylinder, σ_s is the scattering cross section, and σ_t is the total cross section. Intensities were measured as a function of R/h for vanadium, which scatters almost entirely incoherently, and for copper, which has strong coherent reflections. The data for vanadium and copper are in good agreement with the calculations. (auth)

12578 DECAY OF THE ISOMER Eu^{152m_2} (96 MIN). K. Takahashi, M. McKeown, and G. Scharff-Goldhaber (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B763-71(Feb. 22, 1965). (BNL-8510)

The structure of ^{152}Eu is of great interest, since this nucleus is unique is being flanked by two even-even isobars which differ radically from each other in shape: ^{152}Sm is strongly deformed while ^{152}Gd is spherical. Only two states had previously been known in ^{152}Eu: the 13-year ground state (3–) and the 9.3-h isomeric state (0–). A detailed investigation of the decay of a new 96-min isomer, $^{152m_2}Eu$, was carried out. This isomer was first reported by Kirkby and Kavanagh, who found two transitions. A third transition of 18.25 kev (99.9% M1 + 0.1% E2 was detected. The precise energies, and the spins and parities of three excited states of ^{152}Eu were obtained: 89.83 kev (4+), 108.1 kev (5+), and 147.9 kev (8–) (96 min). The half life of the 4+ state was found to be 4×10^{-7} sec, that of the 5+ state $<10^{-8}$ sec. A renewed search for an isomeric transition accompanying the decay of the 9.3-h isomer $^{152m_1}Eu$ (0–) was carried out, especially at lower electron energies (7 – 25 kev) than had hitherto been scanned. This search furnished an upper limit of 0.001% for a transition in the energy range $15 \leq E_{IT} \leq 68$ kev, and of ~0.003% for $8 \leq E_{IT} \leq 15$ kev. The cross section for production of the 96-min isomer by pile neutrons is found to be 1/(820 ± 150) of the production cross section of the 9.3-h isomer. Configurations of Nilsson orbitals are proposed for the ground state of ^{152}Eu and for three excited states involved in the decay of $^{152m_2}Eu$ as well as for $^{152m_1}Eu$ (0–). These are consistent with the observed hindrance factors for the electromagnetic transitions. (auth)

12579 ENERGY LEVELS IN Ho^{166}. Gordon L. Struble, Jean Kern, and Raymond K. Sheline (Florida State Univ., Tallahassee). Phys. Rev., 137: B772-84(Feb. 22, 1965).

The energy levels in ^{166}Ho are studied by means of (d,p) reaction spectroscopy and a Q value of 4025 ± 7 kev is obtained for the ground state. A rotational model is used to interpret the energies and generate state vectors for the experimental levels. Using these vectors and the distorted-wave Born approximation, a theoretical (d,p) spectrum is constructed and compared with the experimental data. (auth)

12580 NUCLEAR MAGNETIC MOMENT OF Pr^{141} FROM THE HYPERFINE STRUCTURE OF DOUBLY IONIZED PRASEODYMIUM. Joseph Reader and Jack Sugar (National Bureau of Standards, Washington, D. C.). Phys. Rev., 137: B784-9(Feb. 22, 1965).

The hyperfine structure in the spectrum of doubly ionized ^{141}Pr was observed by means of a sliding spark discharge and a concave-grating spectrograph. Measurements of the hyperfine patterns resulted in a value for the splitting factor of the 6s electron of $a_{6s} = +0.639 \pm 0.007$ cm^{-1}. The probability density of the 6s electron at the nucleus was calculated by using interpolated values of the energy difference and quantum defect difference for the $4f^6 6s$ and $4f^6 7s$ configurations. Application of the Goudsmit-Fermi-Segre formula yields a value for the nuclear magnetic moment $\mu_I = +4.09 \pm 0.06$ nm. The various contributions to the stated uncertainties are discussed in detail. (auth)

12581 ISOTOPE SHIFT IN THE SPECTRUM OF ERBIUM. PART I. E. Paul Haynes, II, and John S. Ross (Rollins Coll., Winter Park, Fla.). Phys. Rev., 137: B790-2(Feb. 22, 1965).

Using enriched samples, the isotope shift in seven lines of the arc spectrum of erbium was measured with a Fabry-Perot interferometer. The average relative isotope shift for the even isotopic pairs $\Delta\nu(170-168):\Delta\nu(168-166):\Delta\nu(166-164):\Delta\nu(164-162)$ was found to be $1.00:0.96 \pm 0.02:0.94 \pm 0.03:1.23 \pm 0.04$, showing a large change in nuclear deformation between the isotopes with neutron numbers 96 and 94. This results in a predicted intrinsic quadrupole moment for ^{162}Er of 6.30 ± 0.30 b. No pronounced even-odd-staggering was observed for the odd isotope ^{167}Er, since the average value for $\Delta\nu(168-166):\Delta\nu(168-167cg)$ was found to be $1.00:0.52 \pm 0.03$. (auth)

12582 PROPERTIES OF THE LOW-LYING Cu^{63} LEVELS. V. K. Thankappan and William W. True (Univ. of California, Davis). Phys. Rev., 137: B793-9(Feb. 22, 1965).

The nuclear properties of the low-lying levels of ^{63}Cu were calculated with a core-to-particle interaction of the form $H_{int} = -\xi(J_p^{(1)} \cdot j_p^{(1)}) - \eta(Q_c^{(2)} \cdot Q_p^{(2)})$, where $J_c^{(1)}$ and $Q_c^{(2)}$ are, respectively, the angular-momentum operator and the mass quadrupole operator of the core, while $j_p^{(1)}$ and $Q_p^{(2)}$ play a similar role for the particle. Energy levels, single-particle admixtures, and electromagnetic properties of the ground state and excited levels of ^{63}Cu were fitted quite well with relatively few adjustable parameters. The magnetic dipole properties of ^{63}Cu are not in as good agreement with the experimental results as the electric quadrupole properties. (auth)

12583 ANALYSIS OF THE REACTION TYPE (ALPHA, d). B. K. Jain and N. Sarma (Atomic Energy Establishment, Trombay, India). Phys. Rev., 137: B800-6(Feb. 22, 1965).

The angular distribution of the nuclear reaction of the type (α,d) was calculated on the plane-wave Born-approximation theory assuming that both light-particle and heavy-particle stripping processes occur. The interference between the two processes was also taken into account. The angular distribution was computed for the reaction $^{10}B(\alpha,d)^{12}C$ and the results compared with the available experimental data. (auth)

12584 SPIN-ORBIT INTERACTION AND FISSION ANISOTROPY. William R. Gibbs and James J. Griffin (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 137: B807-8(Feb. 22, 1965).

Previous calculations of fission-fragment anisotropies assumed an optical potential with no spin-orbit interaction. It is shown that a similar analysis including such interaction can be carried out and that the earlier results are essentially unchanged. In particular, the apparent discrepancy between theory and neutron-induced experimental data with regard to the effect of target spin on fragment anisotropy is not resolved by including a spin-orbit interaction. Note is taken of the less ambiguous (d,pf) situation for which the target-spin effect is in agreement with theoretical prediction. (auth)

12585 ANISOTROPY OF FRAGMENTS IN THE NEUTRON-INDUCED FISSION OF Pu^{240}, Pu^{242}, AND Pu^{241}. J. E. Simmons, R. B. Perkins, and R. L. Henkel (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 137: B809-13 (Feb. 22, 1965). (LA-DC-6489)

Experimental data are presented for the angular distribution of fragments in the neutron-induced fission of ^{240}Pu and ^{242}Pu, for a range of neutron energies from 0.65 to 8.25 Mev. The results are compared with other available data for even-even target isotopes by means of the parameter K_0^2. It is concluded that excitation energy alone is not sufficient to describe the K_0^2 values for this class of fissioning nuclei. A correlation between K_0^2 and fissionability is obtained. Comparison is also made with data for the even-

odd target nuclei ^{235}U, ^{233}U, and ^{239}Pu. It is concluded that the correlation with fissionability shown by the even-even targets could well explain the major part of the anomalous spin effect shown by the even-odd nuclei. Data for the anisotropy of fragments in the fission of ^{241}Pu are also recorded. (auth)

12586 FRAGMENT ANISOTROPIES IN NEUTRON-, DEUTERON-, AND ALPHA-PARTICLE-INDUCED FISSION. R. B. Leachman and L. Blumberg (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 137: B814-25 (Feb. 22, 1965). (LADC-6434)

Fragment anisotropies were measured from fission of several compound nuclei each formed by two different projectile-target combinations: ^{234}U by n + ^{233}U and α + ^{230}Th, ^{236}U by n + ^{235}U and α + ^{232}Th, ^{238}Np by n + ^{237}Np and d + ^{238}U, ^{239}Pu by d + ^{237}Np and α + ^{235}U, and ^{240}Pu by n + ^{239}Pu and α + ^{236}U. These measurements extended over an energy range of approximately 12- to 25-Mev excitation energy of the compound nucleus. Transmission coefficients were calculated to estimate the mean-square orbital angular momentum $\langle l^2\rangle_{av}$ of the fissioning nuclei required for the theory of fragment angular distributions. At the higher energies attained in the experiment, uncertainties in $\langle l^2\rangle_{av}$ introduced by Coulomb-barrier penetration effects were small, and it was therefore possible to make comparisons between measurements and theory which indicate that the distortion of the compound nucleus at the saddle-point configuration before fission is independent of the total angular momentum and the identity of the bombarding particle. At the lower energies, where the Coulomb parameter $\eta = Z_1Z_2e^2/\hbar v$ is roughly 15, this comparison showed that calculations of transmission coefficients for alpha particles give values of $\langle l^2\rangle_{av}$ in agreement with the data only if careful attention is given to the effects of barrier penetration. At the lowest energies, comparisons of data from ^{239}U and ^{240}Pu indicate that the effect of target spin on fission anisotropy is small. Additional angular distributions from neutron-induced fission of ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, and ^{239}Pu and anisotropies of alpha-particle-induced fission of ^{235}U, and ^{238}U are also reported. (auth)

12587 FISSION MASS YIELD DEPENDENCE ON ANGULAR MOMENTUM. G. P. Ford and R. B. Leachman (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 137: B826-36(Feb. 22, 1965). (LADC-6473)

Fission mass yields from the compound nucleus ^{236}U were measured for 19–29-Mev alpha-particle-induced fission of ^{232}Th and 9–18-Mev neutron-induced fission of ^{235}U with particular attention to the yields of symmetric fission. Decreases in the symmetric fission yield are seen at the 25-Mev onset of (α,2nf) fission and the corresponding 14-Mev onset of (n,2n'f) fission. Above these energies, the symmetric fission yields are approximately 13% greater for alpha-particle-induced fission than for neutron-induced fission at the same excitation energies. This increase is partially explained by the fission-chance ratio of higher energy fissions relative to fissions of the most de-excited nuclei being greater for alpha particles than for neutrons. Angular-momentum-dependent cross sections for these fissions were calculated, and the use of reasonable values of level densities with a rigid moment of inertia resulted in a calculated effect of about one-half this observed effect. The difference remaining is possibly explained by fissions following direct interactions. Mass yields of 9.1–18.1-Mev neutron-induced fission of ^{232}Th and 4.7–18.1-Mev neutron-induced fission of ^{238}U were also measured. Some indication of a small central peak in the mass distribution was observed in the yields from ^{236}U compound-nucleus fission, but not from ^{233}Th compound-nucleus fission. (auth)

12588 PRECISION MEASUREMENTS OF CORRELATED ENERGIES AND VELOCITIES OF ^{252}Cf FISSION FRAGMENTS. H. W. Schmitt, W. E. Kiker, and C. W. Williams (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: B837-47(Feb. 22, 1965). (ORNL-P-579)

Correlated energies and velocities of single fission fragments from the spontaneous fission of ^{252}Cf were measured. Absolute energies and times of flight are obtained with estimated accuracies of ±0.5% from direct comparison measurements with 30- to 120-Mev ^{79}Br, ^{81}Br, and ^{127}I ions from the tandem Van de Graaff accelerator. The post-neutron-emission kinetic parameters obtained from this experiment for ^{252}Cf fragments are compared with pre-neutron-emission quantities obtained from double-time-of-flight experiments of Whetstone and of Milton and Fraser. Of special interest is the fine structure which appears in the post-neutron-emission mass distribution. It is shown that this structure reflects the fine structure observed in the pre-neutron-emission mass distribution, which in turn is known to reflect certain energetically preferred even-even fragment configurations in ^{252}Cf spontaneous fission. Within the ≈2.5% mass resolution of the experiment, no additional fine structure appears as a result of neutron boil-off to specific fragment masses. The number of neutrons ν(M) as a function of fragment mass was calculated from the pre- and post-neutron-emission mass distributions. A universal energy calibration procedure for solid-state detectors for fission fragments is given; this procedure is based on the present absolute fragment energy determinations and takes into account the mass dependence of the pulse-height-versus-energy relation. (auth)

12589 APPLICATION OF TWO-BODY KINEMATICS TO RECOIL STUDIES OF HIGH-ENERGY NUCLEAR REACTIONS. J. B. Cumming (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B848-9(Feb. 22, 1965).

The consequences of the application of the laws of energy and momentum conservation in a general way (two-body kinematics) to the interpretation of recoil studies of high-energy nuclear reactions were investigated. The particular example, ^{149}Tb production by the irradiation of gold with 0.7- to 6.2-Bev protons as reported by Winsberg, is considered. Contrary to his conclusion that detailed information on the mechanism of this reaction could be obtained from such a procedure, it is found that the application of two-body kinematics does not yield a unique solution and is of little help in determining the reaction mechanism of this and probably most other complex high-energy nuclear reactions. (auth)

12590 ANGULAR-MOMENTUM EFFECTS IN COMPOUND-NUCLEUS REACTIONS INDUCED BY 27-Mev ^{14}N IONS. F. E. Durham and M. L. Halbert (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: B850-65(Feb. 22, 1965). (ORNL-P-602)

The angular distribution of particles emitted in the statistical decay of a compound nucleus will show forward-backward peaking if the angular momentum available in the final system is limited. Furthermore, the decay will not be independent of the mode of formation. These effects were demonstrated by measurements of the energy and angular distributions of alpha particles emitted from reactions of ^{14}N with ^{16}O, ^{23}Na, and ^{27}Al at about 27 Mev. The angular distributions were analyzed by the semiclassical theory of Ericson and Strutinski to determine the spin cutoff parameter σ, or equivalently the moment of inertia $\mathcal{I}$. The values of σ ranged from 2.6 for the residual nucleus ^{28}Al to 3.5 for ^{37}Ar. The moment of inertia was approximately $0.9\,\mathcal{I}_{rigid}$. The energy dependence of the level density was determined from the energy spectra. With the simple form $\exp[2(a_1E)^{1/2}]$, good fits were obtained with $a_1 \approx A/10$ for the two heavier residual nuclei. The data did not distinguish between this expression and the form $E^{-2}\exp[2(a_2E)^{1/2}]$; equally good fits were obtained with $a_2 \approx \frac{1}{8}A$. (auth)

12591 ELECTRON SCATTERING BY CALCIUM AT 250 Mev. M. Croissiaux*, R. Hofstadter, A. E. Walker, M. R. Yearian, D. G. Ravenhall, B. C. Clark, and R. Herman (*Stanford Univ., Calif.). Phys. Rev., 137: B865-73 (Feb. 22, 1965).

The doubly magic nucleus of ^{40}Ca was investigated by the electron scattering technique at an incident energy of 250 Mev. The elastic scattering behavior was resolved from the inelastic scattering, and absolute data on cross sections were obtained for both types of events. In the case of the elastic scattering, the first and second diffraction fea-

tures were observed and measured. It was possible to make a comparison of the elastic data with theoretical calculations based on a phase-shift analysis for certain assumed models of the nuclear charge density distribution. The combination of such an analysis with the data, and also with earlier data on the same nucleus, permits the determination of the radius and skin thickness of the ^{40}Ca nucleus with a precision greater than was attainable heretofore. An investigation of the dependence of the density distribution on a third parameter indicates that a Fermi distribution, or models close to this type, are required to fit the experimental data. A Fermi radial charge density distribution with radius c = 3.60 F and skin thickness t = 2.50 F fits the data extremely well. (auth)

12592 CROSS SECTIONS OF SOME REACTIONS INDUCED IN NITROGEN, PHOSPHORUS, COPPER, AND BROMINE WITH NEUTRONS OF ENERGY 14.8 Mev. B. Grimeland, E. Kjellsby, and J. Vines (Universitat, Oslo). Phys. Rev., 137: B878-82(Feb. 22, 1965).

The activities induced in nitrogen, phosphorus, copper, and bromine by (n,2n) reactions were determined both by registration of β particles and by registration of coincidences between annihilation quanta. The agreement between the results obtained was quite good for phosphorus and copper, somewhat poorer for bromine. For nitrogen it was impossible to obtain accurate results from registration of β particles and no comparison could be made. Values for the cross sections of the (n,2n) reactions mentioned and for a number of other reactions are presented. The agreement with earlier measurements is in most cases satisfactory. One exception is the reaction $^{81}Br(n,\alpha)^{78}As$. (auth)

12593 ANALYTIC DISTORTED-WAVE APPROXIMATION FOR HIGH-ENERGY ELECTRON SCATTERING CALCULATIONS. D. R. Yennie*, F. L. Boos, Jr., and D. G. Ravenhall (*Univ. of Minnesota, Minneapolis). Phys. Rev., 137: B882-903(Feb. 22, 1965). (COO-1371-6)

A three-dimensional WKB approximation for high-energy electron scattering on nuclei is derived and approximated analytically in the vicinity of the nucleus. This approximation contains five parameters which can be calculated from the charge distribution and are not adjustable It is applied to calculations of elastic scattering and monopole and quadrupole excitation; the method employed involves an asymptotic expansion in inverse powers of qR, where q is the momentum transfer and R is the nuclear radius. In spite of the several approximations, the calculations reproduce qualitatively all the features of the exact results, such as position and filling in of diffraction minima, and they are quantitatively very good as well. Although the charge and excitation distributions treated are somewhat idealized, it should be straightforward to extend the results to more realistic situations. (auth)

12594 DETERMINATION OF THE NUCLEAR SYMMETRY ENERGY AT 9.8 Mev. I. EXPERIMENT AND RESULTS. J. E. Durisch, R. R. Johnson, and Norton M. Hintz (Univ. of Minnesota, Minneapolis). Phys. Rev., 137: B904-6(Feb. 22, 1965).

The absolute differential cross sections for 9.8-Mev protons elastically scattered from ^{112}Sn, ^{116}Sn, ^{120}Sn, and ^{124}Sn were measured with an accuracy of ±3%. The angular range of the measurements was 25 to 160°. (auth)

12595 DETERMINATION OF THE NUCLEAR SYMMETRY ENERGY AT 9.8 Mev. II. OPTICAL-MODEL ANALYSIS. J. E. Durisch and P. Gould (Univ. of Minnesota, Minneapolis). Phys. Rev., 137: B906-12(Feb. 22, 1965).

In order to determine the nuclear symmetry energy at 10 Mev, an optical-model analysis is made of the elastic-scattering data resulting from the experiment in which ^{112}Sn, ^{116}Sn, ^{120}Sn, and ^{124}Sn targets were bombarded with 9.8-Mev protons. Several sets of geometrical parameters are held constant during the analysis, but none produce real potential-well depths which vary linearly with (N-Z)/A over the isotopic range. The uncertainties inherent in the fitting procedure are fully investigated and an attempt is made to relate them to the errors in the experimental data. (auth)

12596 USE OF ELASTIC-SCATTERING PARAMETERS IN (d,p) STRIPPING CALCULATIONS. William R. Smith (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: B913-28(Feb. 22, 1965). (ORNL-TM-966)

The angular distributions of $^{90}Zr(d,p)^{91}Zr$, $^{52}Cr(d,p)^{53}Cr$, $^{206}Pb(d,p)^{207}Pb$, and Zn(d,p) were calculated by means of the distorted-wave Born approximation in which various optical-model parameter sets were obtained by fitting appropriate deuteron and proton elastic-scattering data. In most cases it was found that parameter ambiguities did not greatly affect the relative angular distributions, but did cause differences of more than a factor of 2 between the resulting spectroscopic factors. Potential ambiguities of the form VR^n = const were shown to be of considerably greater importance for the stripping results than were other types of ambiguities. (auth)

12597 NUCLEAR CHARGE DISTRIBUTION IN FISSION: FRACTIONAL YIELDS OF KRYPTON AND XENON ISOTOPES FROM THERMAL NEUTRON FISSION OF U^{233} AND Pu^{239} AND FROM 14-Mev NEUTRON FISSION OF U^{235} AND U^{238}. Kurt Wolfsberg (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 137: B929-35(Feb. 22, 1965). (LA-DC-6597)

Measurements of fractional cumulative yields of ^{80}Kr through ^{85}Kr, ^{85}Kr, and ^{137}Xe through ^{144}Xe from thermal neutron fission of ^{233}U and ^{239}Pu and of ^{91}Kr through ^{93}Kr and ^{138}Xe through ^{141}Xe from 14-Mev neutron fission of ^{235}U and ^{238}U were made. These data and other published data show that isobaric charge dispersion for fission products with mass number 140 from thermal neutron fission of ^{233}U and mass numbers 138 and 139 from 14-Mev neutron fission of ^{238}U is consistent with the Gaussian curve determined for thermal neutron fission of ^{235}U. This curve is used to estimate empirical values of Z_P, the most probable charge for a beta-decay chain, from the experimental data. From the variation of Z_P with fragment mass, it is indicated that there is a general deviation from unchanged charge distribution of ≈0.6 charge unit in favor of the light fragment for the four fission processes considered as well as for thermal neutron fission of ^{235}U. (auth)

12598 LOW ENERGY NUCLEAR PHYSICS AT THE KRAKOW CENTER FROM 1945 TO 1964. Adam Strzalkowski (Inst. of Nuclear Physics, Krakow and Jagiellion Univ., Krakow). Postepy Fiz., 15: 386-403(1964). (In Polish)

The development of research in low-energy nuclear physics is discussed, with emphasis on the more recent activities. Reaction studies directed at obtaining information on reaction mechanisms and nuclear structure are covered, together with research in the field of nuclear (beta and gamma) spectroscopy aimed at determining nuclear parameters. Investigations of the structure of gross matter by slow-neutron scattering, NMR, and the Mössbauer effect are also considered; and a list of publications is included beginning with 1950. (D.C.W.)

12599 EXPERIMENTAL NUCLEAR PHYSICS AT THE WARSAW CENTER FROM 1945 TO 1964. Zdzislaw Wilhelmi (Warsaw Univ.). Postepy Fiz., 15: 405-22(1964). (In Polish)

The development of experimental nuclear physics after World War II is reviewed, including present activities with nuclear reactions and spectroscopy. Several reactions that have been studied are listed, together with some of the research facilities, including a 3-Mev Van de Graaff accelerator, a 10-Mev proton linear accelerator, a fast-neutron generator, a research reactor, a neutron time-of-flight spectrometer, a magnetic analyzer, and associated electronic equipment. Spectroscopic facilities include several types of spectrographs and spectrometers; decay schemes, longitudinal polarization in beta decay, gamma resonance fluorescence, and electron-capture decay are studied. (D.C.W.)

12600 HYPERFINE STRUCTURE MEASUREMENTS IN ^{75}As, ^{31}P, AND ^{53}Cr. J. M. Pendlebury and K. F. Smith (Univ. of Sussex, Eng.). Proc. Phys. Soc. (London), 84: 849-56(Dec. 1964).

Energy intervals in ^{75}As, ^{31}P, and ^{53}Cr ground state hyperfine multiplets were measured using the techniques of atomic beam magnetic resonance. Values for the interaction constants were found which are consistent with all measured intervals to within the experimental errors. The results are for ^{75}As: A = −66.204(1) mc, B = −0.535(3) mc, g_J = −1.9965(8); for ^{31}P: A = +55.061(10) mc, g_J = −2.00165 (40); and for ^{53}Cr: A = −82.5994(16) mc and B = +0.008(12) mc. (auth)

12601 A CALCULATION OF HYPERFINE STRUCTURE CONSTANTS FOR ^{75}As. J. M. Pendlebury (Cambridge Univ., Eng.). Proc. Phys. Soc. (London), 84: 857-66(Dec. 1964).

The magnetic dipole interaction constant A in ^{75}As was calculated by estimating the atomic core polarization using superposition of configurations and by estimating the intermediate coupling in the ground configuration. The result is −89 Mc compared with the experimental value of −66.204(1) Mc. The agreement is regarded as reasonable within the limitations of the method used. An attempt to estimate the electric quadrupole interaction shows the use of the present theory of intermediate coupling in the ground configuration to be inadequate. (auth)

12602 THE ENERGY LEVELS OF ARGON 36. N. Williams and J. C. Lisle (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 84: 1031-2(Dec. 1964).

The levels of ^{36}Ar were investigated using the reaction ^{39}K(p, α)^{36}Ar. The existence of six excited states in ^{36}Ar was confirmed. (auth)

12603 ROTATIONS AND VIBRATIONS IN DEFORMED NUCLEI. J. P. Davidson (Rensselaer Polytechnic Inst., Troy, N. Y.). Rev. Mod. Phys., 37: 105-58(Jan. 1965).

A general survey of phenomenological, collective-model theories, especially those based upon the hydrodynamic model of rotations and vibrations of a deformed liquid drop, is presented. Details of models of even-even, odd-odd, and odd-A nuclei are given as well as a discussion of electromagnetic moments and transitions in these models. The influence of the vibrating and rotating nuclear surface on alpha and beta decay of deformed nuclei is outlined. The discussion is extended to collective model calculations of the photonuclear process from which information can be obtained on the shape of nuclei in their ground states. Comparison of theory with the results of some recent experiments is given. 272 references. (auth)

12604 NEUTRON CAPTURE DATA AT STELLAR TEMPERATURES. R. L. Macklin and J. H. Gibbons (Oak Ridge National Lab., Tenn.). Rev. Mod. Phys., 37: 166-76(Jan. 1965). (ORNL-P-97)

Neutron capture cross sections are averaged over Maxwell-Boltzmann neutron distributions for temperatures pertinent to slow nucleosynthesis (s process) in red giant stars. Such cross sections, together with isotopic abundances, provide the major quantitative experimental tests of the theory. The cross sections are tabulated at convenient intervals from kT = 5 to 90 kev where data are available. In many cases it was possible to supplement the often fragmentary (as of June 1964) data with evidence from nuclear systematics. 53 references. (auth)

12605 THERMAL NEUTRON ACTIVATION: MEASUREMENT OF CROSS SECTION FOR MANGANESE-53. Hugh T. Millard, Jr. (Univ. of California, San Diego, La Jolla). Science, 147: 503-4(Jan. 29, 1965).

The product of the thermal neutron activation cross section and half life for ^{53}Mn is (350 ± 100) × 10^6 barn-years. If a value of 2 × 10^6 years is assumed for the half-life of ^{53}Mn, then the cross section is 170 barns. This large cross section affords much greater sensitivity for the determination of ^{53}Mn. (auth)

12606 INELASTIC SCATTERING OF NUCLEONS ON NUCLEI AND GREEN'S QUANTUM FUNCTIONS. F. A. Zhivopistsev. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No 4, 45-51(July-Aug. 1964). (In Russian)

Studies were made of inelastic nucleon scattering by a nucleus with one nucleon outside a closed shell at small energies. The reactions (n,n′), (p,p′), (n,p), (p,n), (d,n), (d,p), and (d,n,p) were considered. It is shown that the S-matrix calculations are related to finding two-particle Green functions. The calculations did not consider approximations for weak interactions or the mechanism of the nuclear process. An approximation for the T-matrix permits one to find the cross sections of nuclear reactions wtihout the aid of the ordinary perturbation theory (Born series). In the first approximation the inelastic nucleon scattering on a nucleus with one particle outside the filled shell was determined by free nucleon scattering amplitudes and by magic nucleus optical potentials (tr-auth)

12607 POLARIZATION OF PROTONS SCATTERING ON CARBON. I. Grancha, E. A. Romanovskii, G. F. Timushev, and M. M. Khasani. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 4, 87(July-Aug. 1964). (In Russian)

Polarization of 6.6-Mev protons elastically scattered by carbon was measured, and the results were tabulated. (R.V.J.)

12608 DIFFERENTIAL CROSS SECTIONS OF THE ^{27}Al(p,p)^{27}*Al REACTION FOR LEVELS 7 TO 13 AT E_p = 6.56 Mev. S. S. Vasil'ev, T. N. Mikhaleva, and D. L. Chuprunov. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 4, 88-9(July-Aug. 1964).

Differential cross sections for inelastic scattering of 6.56-Mev protons on ^{27}Al with excitation energies greater than 3 Mev were measured. The results were tabulated, and the error of measurements did not exceed 20%. (R.V.J.)

12609 THE SPONTANEOUS FISSION BARRIER THICKNESS OF THE EVEN-EVEN NUCLIDES. Si-chang Fung. Wu Li Hsueh Pao, 20: 938-9(Sept. 1964). (In Chinese)

It was established experimentally that the spontaneous-fission half life of even-even nuclei $\tau^f_{\frac{1}{2}}$ decreases with increasing values of A or decreasing values of Z^2/A. This behavior was explained by D. Hill and J. A. Wheeler (Phys. Rev. 89: 1102(1953)) by assuming that the heavier nuclei are more strongly distorted; an ellipsoidal distortion could reduce the range thickness, thus causing a decrease in the value of $\tau^f_{\frac{1}{2}}$. The range thickness (b) of spontaneous fission was found to decrease with increasing values of A. It may be assumed that the range thickness is larger than the diameter of the fission fragment; therefore b must decrease with increasing values of A, Z or A − Z. (TTT)

12610 PRECISION MEASUREMENT OF THE HYPERFINE STRUCTURE OF THE $5^2P_{\frac{3}{2}}$ LEVELS AND THE $6^2P_{\frac{3}{2}}$ LEVELS OF ^{85}Rb AND ^{87}Rb. H. A. Schuessler (Universität, Heidelberg). Z. Physik, 182: 289-305(1965). (In German)

The hyperfine structure splitting of the $5^2P_{\frac{3}{2}}$ and the $6^2P_{\frac{3}{2}}$ excited states of RbI was investigated with the optical double resonance method to study the modification of the value of the nuclear quadrupole moment obtained without Sternheimer correction from measurements in states with different principal quantum numbers. The experiments, using isotopic enriched samples of ^{85}Rb and ^{87}Rb, were carried out in the $5^2P_{\frac{3}{2}}$ state without a static magnetic field. In the $6^2P_{\frac{3}{2}}$ state, a static magnetic field was applied. For the $5^2P_{\frac{3}{2}}$ state, the hyperfine structure constants are A(^{85}Rb) = 25.029(16) Mc/s, B(^{85}Rb) = 26.032(70) Mc/s, A(^{87}Rb) = 84.852(30) Mc/s, B(^{87}Rb) = 12.611(70) Mc/s. The corresponding constants for the $6^2P_{\frac{3}{2}}$ state are A(^{85}Rb) = 8.25(10) Mc/s, B(^{85}Rb) = 8.16(20) Mc/s, A(^{87}Rb) = 27.96 (35) Mc/s, B(^{87}Rb) = 3.95(10) Mc/s. The values of the nuclear quadrupole moments, derived from both fine-structure states, can be brought into agreement when the Sternheimer core correction is applied. The Landé factor for the $6^2P_{\frac{3}{2}}$ state is g_J = 1.334(1). (auth)

12611 K-CAPTURE OF THE SILVER ISOTOPES ^{110}Ag AND ^{108}Ag. L. Frevert, R. Schoeneberg, and A. Flammersfeld (Universität, Göttingen, Ger.). Z. Physik, 182: 439-44 (1965). (In German)

The K-electron capture of ^{110}Ag was observed for the

first time using scintillation spectrometers in anticoincidence technique. The ratio of electron capture to β^- decay was determined to be $(0.3 \pm 0.06)\%$. The K-electron capture of ^{108}Ag was remeasured with better accuracy, yielding a relative frequency of $(1.73 \pm 0.12)\%$ for the capture transition to the ground state of ^{108}Pd. (auth)

12612 ANGULAR DISTRIBUTION OF PROTONS EMITTED IN THE REACTION D(n,p)2n. V. K. Voitovetskii, I. L. Korsunskii, and Yu. F. Pazhin. Zh. Eksperim. i Teor. Fiz., 47: 1628-30(Nov. 1964). (In Russian)

The energy spectrum of protons emitted in the D(n,p)2n reaction is measured near the upper limit at angles of 4.5, 10, 15, and 20°. (auth)

12613 THE DECAY OF NEUTRON-DEFICIENT Nd ISOTOPES. NEW ISOTOPE ^{138}Nd. K. J. Gromov, A. S. Danagulyan, L. N. Nikityuk, V. V. Muraveva, A. A. Sorokin, M. Z. Shtal, and V. S. Shpinel (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1644-52(Nov. 1964). (In Russian)

Conversion electrons, γ- and $\gamma\gamma$-coincidence spectra of the ~ 5.5-hour activity in the fraction of neutron deficient Nd isotopes were studied with the aid of the double-focusing $\pi\sqrt{2}$ β spectrometer and scintillation coincidence γ spectrometer. It is shown, that most of the γ transitions observed are related to the ^{139}Pr isotope, excited in the decay of ^{139m}Nd isomer. The ^{139m}Nd → ^{139}Pr decay scheme is proposed. In the conversion electron spectrum were also observed the electrons of the E0-transition in the ^{138}Ce nucleus, excited in the decay ^{138}Nd → ^{138}Pr → ^{138}Ce. The intensity of these electrons decreased also with the half life of about 5.5-hours, which is an experimental confirmation of the existence of the ~ 5.5-hour activity of ^{138}Nd. (auth)

12614 INVESTIGATION OF THE FINE STRUCTURE OF THE ENERGY SPECTRUM OF GAMMA QUANTA PRODUCED BY 18.7 Gev PROTONS ON PHOTOGRAPHIC EMULSION NUCLEI. G. B. Zhdanov, M. I. Tretyakova, and M. N. Shcherbakova (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1664-7(Nov. 1964). (In Russian)

The fine structure of the energy spectrum of γ quanta produced in a photographic emulsion by 19.7 Bev/c protons is investigated in the 140–950 Mev energy range; 222 electron-positron pairs were analyzed. No statistically certain peaks are observed in the spectrum which could be ascribed to sufficiently intense processes of two-photon decay of mesons (η). (auth)

12615 RELATIVE MEASUREMENTS OF THE LONGITUDINAL POLARIZATION OF BETA DECAY ELECTRONS. D. M. Kaminker, V. M. Lobashov, V. A. Nazarenko, L. F. Saenko, G. I. Kharkevich, and A. I. Egorov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 1668-70(Nov. 1964). (In Russian)

Relative measurements of the longitudinal polarization of electrons from the β decay of ^{32}P, ^{114}In, ^{142}Pr, ^{166}Ho, and ^{180}Re are carried out at energy $E_\beta \approx 1250$ kev. Circular polarization of the bremsstrahlung radiation produced as a result of slowing down of β electrons in a lead target is measured. The magnitude of the circular polarization of bremsstrahlung γ quanta produced by β electrons from ^{114}In, ^{142}Pr, ^{166}Ho, and ^{180}Re is compared with the circular polarization of ^{32}P β electron bremsstrahlung γ quanta. The electron energy was selected with aid of a magnetic lens spectrometer. The following values were obtained for the ratio of the longitudinal polarization: $P_{^{114}In}/P_{^{32}P} = 0.960 \pm 0.015$, $P_{^{142}Pr}/P_{^{32}P} = 0.934 \pm 0.015$, $P_{^{166}Ho}/P_{^{32}P} = 0.942 \pm 0.015$, $P_{^{180}Re}/P_{^{32}P} = 1.005 \pm 0.016$. (auth)

12616 INVESTIGATION OF THE GAMMA-RADIATION FROM Xe^{137} AND Xe^{138}. V. V. Ovechkin and N. N. Demidovich. Zh. Eksperim. i Teor. Fiz., 47: 1671-6(Nov. 1964). (In Russian)

The isotopes ^{137}Xe and ^{138}Xe obtained in an aqueous solution of ^{235}U by irradiating the latter with neutrons from a Po–Be source slowed down in paraffin are investigated. The gaseous fission products were removed from the uranium solution by a helium stream and the xenon isotopes were absorbed by cooled activated coal. The measurements were performed on a scintillation γ spectrometer. New data on the relative intensities and total γ yields from ^{137}Xe and ^{138}Xe decay are obtained. In this way the decay schemes of these isotopes can be considerably improved. The total γ yields for ^{137}Xe are: 0.15 Mev–5%, 0.44 Mev–33%, and for ^{138}Xe the yields are: 0.16 Mev–5%, 0.25 Mev–37%, 0.42 Mev–23%, 1.73 Mev–16%, and 1.99 Mev–11%. (auth)

12617 THE $O^{16}(\pi,\pi')$ 4α REACTION FOR 80 Mev π^+ MESONS. B. P. Afanasev, V. E. Kosmach, and V. I. Ostroumov (Leningrad Polytechnic Inst.). Zh. Eksperim. i Teor. Fiz., 47: 1687-92(Nov. 1964). (In Russian)

Disintegration of ^{16}O nuclei into four α particles as a result of inelastic scattering of 80-Mev mesons (π^+) on the nuclei was investigated with aid of photographic emulsions. The cross section for the reaction was found to be 7.3 ± 1.7 mb. A kinematic analysis of the stars revealed that in more than half of the reactions direct emission of the α particles occurs with formation of an intermediate ^{12}C nucleus with an excitation energy of 9.6 and 13 Mev. (auth)

12618 DISINTEGRATION OF $_\Lambda H^3$ IN A COULOMB FIELD AND PICKUP OF LAMBDA-PARTICLES BY HEAVY NUCLEI. N. N. Kolesnikov and R. V. Vedrinskii (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1740-1(Nov. 1964). (In Russian)

A preliminary study of the disintegration of $_\Lambda H^3$ in the Coulomb field of heavy nuclei is carried out. It is shown that the cross section for the process may be very large. The hyperons released may be captured by the nuclei with an appreciable probability. (auth)

12619 MASS DIFFERENCE OF MIRROR NUCLEI. I. G. Ivanter and M. A. Troitskii. Zh. Eksperim. i Teor. Fiz., 47: 1773-6(Nov. 1964). (In Russian)

The change in the ground state energy of nuclei due to a change of a proton for a neutron is considered by the interacting quasi-particle method. An equation is obtained for the mass difference of mirror nuclei. Comparison with experiment is carried out. The constant $f_- = 0.4$ describing scalar interaction of quasi-particles on the Fermi surface is found. (auth)

12620 ELECTROMAGNETIC TRANSITION INTENSITIES IN DEFORMED NUCLEI. Yu. T. Grin and I. M. Pavlichenkov. Zh. Eksperim. i Teor. Fiz., 47: 1847-54 (Nov. 1964).

The intensity ratios of electromagnetic single particle transitions in deformed odd nuclei are considered. It is shcwn that the corrections to the nuclear wave functions due to the interaction between rotation and intrinsic motion can explain the observed deviations from Alaga rules and asymmetry in the behavior of electric dipole transitios with $\Delta K = 0$ and $\Delta K = \pm 1$. The theoretical calculations are in agreement with experiment. (auth)

12621 RELATIVISTIC COULOMB FUNCTIONS. V. G. Gorshkov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 1984-8(Nov. 1964). (In Russian)

An expansion of the relativistic Coulomb Green function and wave function of a spinor particle with a definite asymptotic momentum p in terms of $(\alpha Z)^2$ is obtained which is true for arbitrary values of p. At high energies E and small angles $\vartheta \lesssim 1/E$ the expansion contains an additional smallness parameter of the order of 1/E. (auth)

12622 INVESTIGATION OF IONIZATION LOSSES OF RELATIVISTIC PARTICLES IN NUCLEAR EMULSIONS. Z. V. Anzon, A. Kh. Vinitskii, Zh. S. Takibaev, I. Ya. Chasnikov, and Ts. I. Shkhova (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 47: 2051-4(Dec. 1964). (In Russian)

Relative ionization measurements in Nikfi-P and Ilford G-5 emulsions in the energy range attainable in accelera-

tors are presented. Within the experimental errors the ratio of the ionization value on the plateau of the ionization curve to the minimum ionization value is the same for the two emulsions. The mean value of the ratio is 1.104 ± 0.010. The observed ionization-momentum dependence is in agreement with that calculated from the Sternheimer equation with the parameters I = 270 ev and T_0 = 2 kev. (auth)

12623 ANGULAR DISTRIBUTION OF γ-RAYS PRODUCED IN THE FISSION OF U^{235}, U^{233} AND Pu^{239} BY THERMAL NEUTRONS. G. A. Petrov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 2064-6(Dec. 1964). (In Russian)

The relative yields of γ quanta produced in the fission of ^{235}U, ^{233}U, and ^{239}Pu are measured for 9 angles between the directions of the recorded γ quanta and fission fragments. The data are treated by the mean square method. For all three nuclei the probability of γ-quantum emission in the direction of fission was higher than in the perpendicular direction. The anisotropy values are (11 ± 1), (13 ± 1), and (16 ± 1)% for ^{235}U, ^{233}U, and ^{239}Pu, respectively. (auth)

12624 KERNPHYSIKALISCHES PRAKTIKUM MIT EINER EINFUHRUNG IN DIE MESSTECHNISCHEN GRUNDLAGEN. (Nuclear Physics Practices with an Introduction to Measurement Fundamentals). Wolfgang Riezler and Konrad Kopitzki. Stuttgart, B. G. Teubner Verlagsgesellschaft, 1963. 160p.

A laboratory manual for use in nuclear physics laboratories in German universities and technical schools is presented. Radiation detection instruments, their functions, and their operation are considered; and exercises from various areas of nuclear physics are given. (J.S.R.)

12625 LECTURES ON THE MANY-BODY PROBLEM. S. Takagi. Bombay, Tata Inst. of Fundamental Research, 1963. 61p.

A review on the treatment of nuclear many-body problems is presented, with consideration of the method of eigenmodes, stability of Hartree-Fock states, pairing correlation, method of Green's functions, particle-hole correlation, and collective oscillation of non-dosed shell nuclei. (D.C.W.)

12626 (REPORT) CROSS-SECTION OF INELASTIC INTERACTION OF NUCLEONS WITH NUCLEI OF GRAPHITE AT 10^{12} EV-ENERGIES. B. B. Tolkachev. p.272-7 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The asymptotic behavior of the cross section of nuclear interactions is an indicator of theoretical correlations with the transparency of the nucleon at high energies. The mean free path L is related to the cross section σ by $L = A/N_a\sigma$, where A is the atomic number and N_a is Avogadro's number. The mean free path for the inelastic interaction of nucleons in C and the ratio of the free paths in C and Pb were determined at energies of about 10^{10} ev. The mean free path of 10^{10} ev nucleons in Pb was found to be about 90 gcm^{-2}, corresponding to a cross section of 220 mbarn. The tests were carried out at 10^{12} ev, in airplanes at 12 and 9 km. The electron–photon avalanches in the Pb sheets were detected by a series of ionization chambers. The energy of the avalanches was determined by ionization induced. The $\pi^{\pm}$ mesons in the nuclear-active component were calculated from the $\mu^{\pm}$ mesons; at 12 km they amount to about 10% of the nucleon flux of the same energy. The dependence of σ on the fraction of the energy transferred by π^0 mesons was studied. The inelastic cross section of the 10^{12} ev nucleons on C was found to be 218 ± 25 mbarn, agreeing well with the values obtained for 10^{10} ev. The elementary cross section σ_0 was found to be 33 ± 7 mbarn on the basis of the optical model of the nucleus. (TTT)

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Refer also to abstracts 11468, 12006, 12008, and 12463.

12627 (AFCRL-64-429) A RELATIONSHIP FOR PLASMA SHEATHS ABOUT LANGMUIR PROBES. Scientific Report No. 1. Richard T. Bettinger and E. Harris Walker (Maryland. Univ., College Park). Jan. 1964. Contract AF19(628)-2792. 20p. (AD-603008). $1.00 (OTS).

An analytical relation for the sheath about a spherical Langmuir probe was empirically derived from calculated data. The relation reproduces the data within 10 per cent. A semi-quantitative analysis verifies the functional dependence of this relation and a similar analysis develops the corresponding relationship for cylindrical geometry. In the absence of sophisticated calculations in the cylindrical case a detailed evaluation of coefficients is not possible. (auth)

12628 (AFCRL-64-473) ON RADIATION OF ELECTROMAGNETIC AND ELECTROACOUSTIC WAVES IN PLASMA. Scientific Report No. 29. James R. Wait (National Bureau of Standards. Central Radio Propagation Lab., Boulder, Colo.). June 8, 1964. Contract AF19-PRO-62-201. 16p. (AD-604435) $1.00(OTS).

Radiation from current distributions in lossless, compressible plasma media is considered. A linearized theory is used such that the isotropic electron plasma is regarded as a single fluid continuum. It is found that a considerable portion of the power is radiated as an electroacoustic wave. (auth)

12629 (AFOSR-64-1143) STUDIES ON OPTICAL SCATTERING AS A TECHNIQUE FOR PLASMA DIAGNOSTICS. Scientific Report No. 1. S. E. Schwarz (California Inst. of Tech., Pasadena). May 1964. Contract AF49 (638)-1322. 125p. (AD-603738). $4.00(OTS).

When a pulse of intense light from a giant-pulse laser passes through a plasma, a very small fraction of the light is scattered out of the beam as a result of "Thomson" scattering by free electrons. Under suitable conditions the intensity of the scattered light is proportional to the density of free electrons, while its spectral distribution is related to the velocity distribution of the free electrons through the Doppler formula. Theoretical considerations are discussed. An apparatus for conducting scattering experiments was constructed. Measurements conducted at various times in the development of an afterglow plasma indicate Doppler broadening of the scattered light; the broadening disappears as the electrons cool during the first three microseconds of the afterglow. Measurements of electron density as a function of time were made in the afterglow. Two unexpected laser-plasma interactions were observed. The first is designated as 'induced plasma luminosity' and the second as 'giant scattering.' Both effects appear to be related to the presence of hydrocarbon impurities in the gas. (auth)

12630 (ARL-64-191) THERMAL CHARACTERISTICS OF A HIGH AND LOW MASS FLUX ARGON PLASMA JET. C. J. Cremers and E. Pfender (Minnesota. Univ., Minneapolis. Heat Transfer Lab.). Nov. 1964. Contract AF33(657)-7380. 67p. (AD-609622). $3.00(OTS).

Thermal characteristics are determined in plasma jets emanating from a plasma torch. A grating spectrometer was used to determine the temperature fields of high- and low-mass flux jets generated by a 400-amp arc. The temperature distributions in a cross section close to the nozzle were determined as well for a number of other mass flows at a 400 amp current input. Also, similar distributions were obtained for the high and low mass flux cases at 600 amps. A calorimeter was used to measure the energy output of the torch for various mass flows. Additionally the radiation from the torch was measured with a radiometer. The steadiness of the turbulent high mass flux jet and the meaning of the measured temperatures are discussed. (auth)

12631 (AROD-4832.2) THEORY OF THE LASER INTERFEROMETER AND ITS USE IN PLASMA DIAGNOSTICS. Scientific Report No. 1. J. B. Gerardo, J. T. Verdeyen, and M. A. Gusinow (Illinois. Univ., Urbana. Electrical Engineering Research Lab.). Dec. 1, 1964. 95p. OTS.

The theory of the laser interferometer and its application in investigations of relatively dense to very dense gaseous plasmas is discussed. It is shown that the sensitivity of the interferometer can be greatly improved by utilizing a spherical geometry reference cavity rather than one formed by planar mirrors. The parameters that determine the sensitivity of a spherical geometry laser interferometer are discussed and detailed theory of such is given. Particular emphasis is placed on determining the maximum frequency response, and it is shown that by proper selection of the parameters and detection techniques, it is possible to detect resonances at rates in excess of 50 per microsecond. (auth)

12632 (EUR-CEA-FC-247) DENSITIES DES ATOMES EXCITES DE L'HELIUM I DANS UN PLASMA HORS DE L'EQUILIBRE THERMODYNAMIQUE LOCAL. (Densities of Excited Atoms of Helium I in a Plasma Out of Local Thermodynamic Equilibrium). H.-W. Drawin (European Atomic Energy Community and France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Apr. 1964. 30p. Dep.(mn).

For nonthermal plasmas the population densities of the ground level and the lower lying excited states can deviate considerably from a Saha and Boltzmann population density, which is only valid for plasmas in local thermal equilibrium. In order to obtain the actual population densities of the lower lying states of the He I atom in a nonthermal, optically thin or partially optically thick plasma, the corresponding rate equations have been solved. Owing to the metastable state 2^3S we have distinguished between the singlet and the triplet system. The coupling between the two systems has been accomplished by appropriate collisional processes. Numerical values are given for the population densities in terms of Saha population densities for both the lower singlet and triplet levels in the case of an optically thin plasma. The relaxation times necessary for establishing a steady state have been calculated. The influence of the triplet-system on the particle densities of the singlet-system is shown. For low electron densities the ratio $n_t(\text{triplet})/n_t(\text{singlet})$ becomes larger than 3. By solving the complete system of rate equations and comparing the solutions with measured densities one can derive unknown total cross sections for reactions between excited states. (auth)

12633 (IPP-1/10) KURZZEITAUFNAHMEN DER INTERFERENZ-STREIFENVERTEILUNG UBER DEN QUERSCHNITT DES ENTLADUNGSGEFASSES EINER THETAPINCHANLAGE. (Short-time Photography of Interference Line Distribution Over the Cross Section of a Discharge Vessel of a Theta Pinch Device). Franz Peter Kuepper (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). May 1963. 69p. Dep.(mn).

Short-time photography of interference line distribution over the surface of the discharge tube cross section was used to determine the influence of excited hydrogen molecules, molecular ions, atoms, and ions and impurities on the displacement of the interference line and to evaluate the radial symmetry of the electron density distribution. The results showed that the displacement is an accurate measurement for changes in electron density. Photographs of the "zero order" yield directly, without evaluation, the symmetry behavior of the electron density. (J.S.R.)

12634 (IPP-6/22) ÜBER STOSSWELLENARTIGE LÖSUNGEN DER MOMENTENGLEICHUNGEN FÜR EIN PLASMA MIT ANISOTROPEM DRUCK. (Collision Wave-like Solutions of the Momentum Equations for a Plasma with Anisotropic Pressure). Helmut Bergold (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). July 1964. 61p. Dep.(mn).

Numerical collision-wave-like equations can be found, at sufficiently low equilibrium pressures, for the one-dimensional stationary momentum equations of the Boltzmann equation with and without collision terms for a plasma in a magnetic field. The anisotropy of the pressure tensor is still considerable upon addition of the dissipation. The solutions of the 10-moment approximation without collision are, for individual values of the equilibrium parameter, solitary waves of very simple structure, but often form long complicated wave trains. For larger equilibrium pressures or smaller values of the electron/ion mass ratios, the solutions were singular. For linearized 10- and 13-moment equations, one can—in relation with these singularities—for low and high pressures detect characteristic variations in the behavior of the solutions. The 13-momentum equation yields no improvement with respect to the lower approximations. The heat currents were almost inadmissibly large in the course of the integration; also singularities occurred. (tr-auth)

12635 (IPP-8) CHART FOR QUICK DETERMINATION OF CONDITIONS OF PROPAGATION OF ELECTROMAGNETIC WAVES IN MAGNETO-ACTIVE PLASMA. Jiří Ďatlov (Československá Akademie Věd, Ústav Fyziky Plazmatu, Prague). Feb. 1962. 12p. Dep.(mn).

A nomograph is presented, suitable for determination of the region of propagation of the individual modes of electromagnetic waves in a magneto-active plasma. The nomograph permits readings directly in units of magnetic induction, concentration of electrons, and frequency of the wave used. (auth)

12636 (IPPJ-29) TABLES FOR MICROWAVE REFLECTION COEFFICIENTS FROM AN INHOMOGENEOUS PLASMA COLUMN IN A RECTANGULAR WAVEGUIDE. Hideo Ikegami and Akizi Outi (Nagoya, Japan. Univ. Inst. of Plasma Physics). Aug. 1964. 374p. Dep.(mn).

The microwave reflection method for the measurement of various parameters of plasmas is examined. The probing electric field of TE_{10} mode is parallel to the axis of the column. The numerical calculation of the reflection coefficients is performed on an electronic computer. As the results, amplitudes and arguments of the reflection coefficients, as well as the voltage standing wave ratio, are tabulated for plasma parameters. The advantage of the microwave reflection method is that the probing microwave frequency is not limited by the electron plasma frequency, and that the method is effective in a longitudinal magnetic field. The tables make possible determination of the electron density on the axis of the plasma column and the effective collision frequency of electrons with known plasma radius and waveguide dimension. (auth)

12637 (LA-3202-MS) SEMIANNUAL STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR PERIOD ENDING OCTOBER 20, 1964. (Los Alamos Scientific Lab., N. Mex.). Nov. 1964. Contract W-7405-eng-36. 141p. Dep.; $4.00(OTS).

Research and development directed toward pulsed confinement systems for plasma production are reported. Efforts in research program on the caulked cusp were directed toward development of confining forces having the hydromagnetic stability of quadrupole field nulls with bridged field lines between cusps to stop excessive plasma leakage inherent in the nonadiabatic behavior of particles in the region of a field null. Discussions are included concerning magnetic field requirements, containment field shape and stability, magnetic design concepts, aspects of energy storage, electrolytic resistors, and electric switches. Requirements for accurate positioning of the doughnut Cu and steel rings are also discussed along with those for injection. Calculations for use in design of the caulked cusp magnetic field are presented. Progress in construction of a caulked cusp linear model is reported. A computer program for IBM-7094 to compute the speed at which pulsed fields penetrate infinite hollow cylindrical conductors and to compute the electric field at the surface of such conductors is described. Installation of an improved vacuum system and plasma gun to reduce impurities such as C and O ions in plasma is discussed. Measurement of electron densities in a transverse injection experiment using a He–Ne laser-interferometer is reported. Other uses of the interferometry technique are

discussed. Developments in high-density plasma focus studies are reported and the design of a hydromagnetic coaxial gun used in these investigations is described. Results of experiments with the Scylla(IV) theta-pinch at low filling pressure producing stable, hot plasmas without the presence of magnetic bias fields are reported. Results show that neutron-producing plasmas were formed at filling densities of 10 to 50 μHg. Results of numerical studies of the theta pinch in the low-density regime indicate that it operates in a classically predictable way. The vacuum ultraviolet spectrum of Scylla, of interest in astrophysics, is being studied. Traces of Fe added to Scylla discharge resulted in the production of prominent solar spectral lines at 170 to 220 Å that were previously unidentified. Spectrogram reproductions are included. Installation of a power crowbar in Scylla IV and recabling of the primary capacitor bank are reported. Experimental work to test the feasibility of rotational plasma acceleration in crossed electric and magnetic fields for use in generating and heating plasmas in the minimum B systems was continued. Results of computations concerning nonadiabatic particle orbits in an idealized cusp field are discussed along with those computed for a stuffed-cusp field. Methods for use in computation of magnetic and electric fields in cases in which the first step is to solve a partial differential equation are discussed. The design and development of constant-current power supplies for capacitor bank charging is described along with development of 50-kv ignitrons and 10-kv high-density capacitors. (J.R.D.)

12638 (MATT-312) REMARKS ON THE I-V CHARACTERISTIC OF A HIGHLY IONIZED SEMI-COLLISIONLESS CESIUM PLASMA. N. D'Angelo (Princeton Univ., N. J. Plasma Physics Lab.). Nov. 1964. Contract AT(30-1)-1238. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

If no heating of the ions of the "main" distribution is allowed, a density drop of only about 15% can occur when voltage is applied between the hot plates. It would seem that a process similar to heating of the ions by the current might be effective. Another possibility is the enhancement of ion losses at the end plates by ion sound waves, which are excited for sufficiently large V. (auth)

12639 (NASA-TR-R-219) CHARACTERISTICS OF A CONTINUOUS-FLOW INDUCTION PLASMA ACCELERATOR. J. D. Brocks, W. D. Beasley, and R. L. Barger (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). Feb. 1965. 27p. $2.00(OTS).

Characteristics of continuous-flow induction plasma accelerators with a 10-kilocycle, single-phase driving coil on supersonic nozzles were studied. Pressure measurements and vane-deflection measurements were made in a 15-centimeter-diameter accelerator at various mass flow rates. Charged-particle velocities were obtained in 15-centimeter-diameter and 10-centimeter-diameter accelerators by measuring with photoelectric detectors the time required for a change in flow luminosity to travel a known distance. Pressure-probe measurements indicated that the entire flow, including the boundary layer and the separated-flow region, was accelerated in the 15-centimeter-diameter accelerator. The largest increase in pitot pressure was 250 percent of the cold-flow value with 20 kilowatts of 10-kilocycle driving power. The charged-particle velocities increased as the mass flow rate was reduced and as the power was increased. The maximum charged-particle velocity obtained was 40,000 meters per second in the 10-centimeter-diameter accelerator. Average velocity and thrust obtained from vane-deflection measurements were in agreement with those obtained from pressure-probe measurements. (auth)

12640 (R63SD91) SHOCK PRODUCED PLASMA RESPONSE TO MICROWAVE IRRADIATION. G. W. Bethke and A. D. Ruess (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Nov. 1963. Contract AF30(602)-1968. 55p. (AD-424404). $5.60(OTS).

At elevated microwave power levels incident on a shock front, the deposition of r-f energy causes non-equilibrium ionization enhancement in the vicinity of (r-f) critical electron density located in the thermally ionizing region near the shock front. Subsequently this ionization "shield" grows toward the shock front while its peak electron density increases to several times the critical density. As this happens, the microwave reflection coefficient of the plasma increases, shielding the main body of plasma from the microwave field. This r-f-induced plasma shield continues to grow in electron density as that section of plasma is swept back from the shock front away from the microwave interaction region or if the r-f power is turned off. If the r-f power is great enough, the microwave-induced plasma shield appears to break away from the shock front and rapidly propagates on ahead towards the r-f source at several times the shock velocity. This microwave-induced "separated shield" plasma runs ahead of the shock front only above some critical r-f power density, which is well below the unshocked gas breakdown power level and which appears to be primarily dependent on the unshocked gas and gas pressure, and less dependent on the shock conditions. (auth)

12641 (RLE-TR-423) ANALYSIS OF ELECTRON BEAM-PLASMA SYSTEMS (thesis). Philip E. Serafim (Massachuetts Inst. of Tech., Cambridge. Research Lab. of Electronics). July 31, 1964. Contract DA36-039-AMC-03200(E). 100p. (AD-609023).

The interaction between an electron beam and a plasma in metallic waveguides and in the presence of an external longitudinal magnetostatic field is analyzed. Plasma ions and electrons are considered. The treatment refers to a temperate plasma. By use of a multispecies theory, the treatment may be extended to warm plasmas. The electron beam is rectilinear and has a well-defined unperturbed velocity. This velocity is assumed to be uniform over the waveguide cross section. Modifications for nonuniform velocity are also presented. The treatment is valid for slow and fast waves and for relativistic beam velocities. An exact analysis is made of the beam-plasma waveguide, based on the linearized Maxwell equations and the Lorentz force equation. The "operator" dielectric tensor description of the beam-plasma medium is introduced. The properties of this tensor are examined and the boundary conditions are formulated in terms of the elements of this tensor. The field analysis for the beam-plasma system is made, and the dispersion equation and the determinantal equations are derived from the satisfaction of the boundary conditions. Cutoffs, resonances, slow waves, and the quasi-static approximation are studied. Some variational theorems for this system are studied. A solution of the plasma waveguide problem by a coupling-of-modes theory is given. The theory of coupling of empty-waveguide modes and quasi-static modes for the approximate description of a general gyrotropic medium is formulated. The results are specialized for plasma waveguides, and the case of a completely filled circular plasma waveguide is examined in detail. (auth)

12642 (SSD-TDR-64-170) DESIGN, ADJUSTMENT, AND OPERATION OF AN OFF-AXIS SCHMIDT SPECTROGRAPH FOR PLASMA APPLICATIONS. E. J. Eastmond and E. B. Turner (Aerospace Corp., El Segundo, Calif.). Sept. 10, 1964. Contract AF04(695)-269. 37p. (AD-608279). $2.00(OTS).

A large aperture spectrograph designed for plasma research applications is described. This instrument, which uses an off-axis Schmidt optical system, has a relative aperture of f/6 and a dispersion of 23 Å/mm in the first order. Either photographic film or photomultiplier tubes may be used to record the spectra. The design and characteristics of the optical system are discussed, and a detailed description is given of the alignment and adjustment procedure which is somewhat different from that of conventional spectrographs. The operation of the instrument, which includes the use of the photographic camera, the photomultiplier readout head, and the setting of the plane

gratings for various spectral ranges is described in detail. Several sample spectra which may be used as reference standards are shown. Examples are given of applications for which the spectrograph was used. (auth)

12643 (SU-ML-1238) STUDIES OF PLASMA OSCILLATIONS. Quarterly Status Report No. 19, June 1, 1964–August 31, 1964. (Stanford Univ., Calif. Nuclear Technology Labs.). Oct. 1964. Contract At(04-3)-326. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Plasma oscillations are studied with the objective of determining and explaining the mechanisms for the growth of instabilities and oscillations in a gaseous discharge, with particular emphasis on the action of sheaths and wave interactions in the discharge. The effects of parameters such as geometric shapes and boundaries, magnetic field, pressure, and velocity distributions are taken into account. (N.W.R.)

12644 (FTD-TT-64-101) PLASMA DIAGNOSTICS. S. Lukyanov (Lukianov). Translated from Metaniereba Tekhn., No. 11, 14–17(1959). 12p. (AD-609147). $1.00 (OTS).

Described are measured methods for the temperature and density of a plasma and changes in its shape, and the initial stages of a thermonuclear reaction. It is also pointed out that attainable temperatures run to several millions of degrees and that the stability lifetimes lie between 10^{-6} and 10^{-3} sec. (auth)

12645 ON THE DYNAMIC MECHANISM IN THE FAST THETA-PINCHED PLASMA. Masuo Shindo and Nagayasu Ikeda (Tokyo Inst. of Tech.). Bull. Tokyo Inst. of Tech., Ser. B, No. 54, 51-61(Sept. 1963).

The mechanisms of the rapid change of the reverse magnetic field on the fast theta pinch are explained consistently, taking account of the existence of the radial component of the current in the discharge tube with a finite length or in that of Cylla type. The mechanisms of the accompanying behaviors, such as the rotating motion of plasma and its unexpectedly great temperature rise, are also given reasonable explanations. (A.G.W.)

12646 SINGULAR SOLUTIONS AND THE THEORY OF FUSION. Thiounn Mumm. Compt. Rend., 259: 2366-8 (Oct. 12, 1964). (In French)

The conditions under which the wave functions of two particles can be combined to form the wave function of a new particle (the result of their fusion) are studied. It is shown that the combination of singular solutions of the wave equations is generally impossible. A mass-energy relation is obtained, and a system of r particles is considered. (D.C.W.)

12647 MEASUREMENT OF THE DENSITY OF A PLASMA BY A GAS LASER. Claude Gormezano (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 259: 2805-8(Oct. 26, 1964). (In French)

The measurement of the electron density of a plasma created by azimuthal compression, by means of an interferometer with a gas laser (Ne–He) source, is described and discussed. (tr-auth)

12648 NON-LINEAR THEORY OF A DRIFT-CYCLOTRON INSTABILITY OF A NON-ISOTHERMAL PLASMA. A. B. Mikhailovskii (Kurchatov Inst. of Atomic Energy, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 1068-71(Oct. 11, 1964). (In Russian)

Equations which take into account nonlinear effects are analyzed to determine the low-frequency or cyclotron instability of a inhomogeneous, nonisothermal plasma ($T_e \gg T_i$). The increment of the cyclotron oscillations is relatively small with weak coupling between oscillations. The nonlinear interaction between the oscillations can be described by a theory involving weak turbulence. Equations for the charge density are found, and correlation functions are derived in the usual manner. It is found that the cyclotron oscillations are unstable, if the electron drift velocity exceeds the phase wave velocity ($v_z^* > \omega/k_z$). Hence, this instability is called a drift-cyclotron instability. The intensity of the cyclotron oscillations is above the thermal level, and the oscillations can be detected experimentally. The interaction of plasma particles with the cyclotron oscillations should lead to anomalous diffusion, but the diffusion rate is relatively small due to the small scale of the oscillations. The diffusion coefficient D is estimated by averaging the electron distribution according to a quasi-linear approximation. (TTT)

12649 PRODUCTION OF ENERGY BY FUSION AND GENERAL PROPERTIES OF PLASMAS. M. Bayet (Faculte des Sciences, Toulouse). Genie Chim., 90: 12-16(July 1963). (In French)

The various possible energy sources (solar radiation, nuclear fission, natural radioactivity, organic, and inorganic chemical reactions) are briefly examined. The energy yield per unit of available material was compared for chemical reactions (water formation, 2.5 ev/molecule formed), fission reactions (^{235}U fission, 0.8 Mev/amu), and fusion reactions (^2H yielding $^3He + n$, 0.8 Mev/amu). Of available materials for the latter two examples, ^2H is more available by a factor of about 200, although breeders may be used to increase the amount of ^{235}U in natural U. Energy production is described in terms of power per unit of volume, and a table is given in which this value is estimated for a plasma, industrial operations, man, the earth, and the sun. Surface phenomena are also examined where applicable, and compared to solar radiation. The eventual use of energy produced by fusion and appropriate relations of plasma properties are discussed. A positive energy balance between fusion-produced energy and that lost by radiation may be reached in a region around $10^{9\circ}K$. A greatly rarefied gas at an extremely high temperature must be used, but still the problem of confinement remains. Cyclotron radiation not reabsorbed by the medium may render the energy balance negative at all temperatures. (BBB)

12650 STRUCTURE OF THE DISTURBED ZONE IN THE VICINITY OF A CHARGED BODY IN PLASMA. A. V. Gurevich (Lebedev Inst. of Physics, Moscow). Geomagnetism Aeronomy, 4: 1-11(1964).

Disturbances produced in plasma by a charged spherical body with radius small with respect to the Debye radius are examined. The distribution of the electric field and of electrons and ions is found for various field potentials at the surface of the body. (auth)

12651 INSTABILITY OF THE DISTURBED ZONE IN THE VICINITY OF A CHARGED BODY IN PLASMA. A. V. Gurevich (Lebedev Inst. of Physics, Moscow). Geomagnetism Aeronomy, 4: 192-8(1964). Translated from Geomagnetizm i Aeronomiya, 4: 247-55(1964).

An investigation was made of the stability of the disturbed zone in the vicinity of a body in plasma and charged to the potential φ_0. It is demonstrated that when $T_e > T_i$ and $\varphi_0 \sim 0$, instability develops with respect to longitudinal waves. When $T_e > 1.7\ T_i$, the whole region of potentials $\varphi_0 \gtrsim 0$ in unstable. Conversely, the region of significant negative potentials $\varphi_0 < -2.5\ kT_e/e$ is stable for any value of the ratio T_e/T_i. The disturbed zone in the vicinity of very large bodies $R_0 \gg c/\omega_0$ (where R_0 is the size of the body, and ω_0 is the Langmuir frequency) is unstable with respect to transverse electromagnetic waves. (auth)

12652 THE EFFECT OF AN ELECTRIC FIELD ON DISTURBANCES AROUND A MOVING BODY IN PLASMA. Yu. M. Panchenko and L. P. Pitaevskii (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR and Inst. of Physical Problems, Academy of Sciences, USSR). Geomagnetism Aeronomy, 4: 199-202(1964). Translated from Geomagnetizm i Aeronomiya, 4: 256-9(1964).

The results of the calculation of electron and ion concentrations at great distances from a moving body in plasma are presented. It is assumed that the plasma is greatly rarefied, and that the velocity of the moving body is much greater than the thermal ion velocity. (auth)

12653 ON OSCILLATIONS OF WEAKLY NONHOMOGENEOUS PLASMA. E. E. Lovetskii and V. P. Silin (Lebedev Inst. of Physics, Moscow). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 822-7(1964). (In Russian)

The oscillations of a weakly nonhomogeneous plasma are investigated in the geometrical optics approximation. Formulas were obtained defining the oscillation spectra of the weakly nonhomogeneous plasma in case of multidimensional nonhomogeneity for the field equations of an arbitrary order. By means of these formulas there were considered high-frequency oscillations of the magnetoactive rarefied plasma as well as quasi-longitudinal oscillations of the magnetoactive plasma taking into account the spatial dispersion and magnetohydrodynamic waves. (auth)

12654 PLASMA NOISE OF HIGH-FREQUENCY DISCHARGE IN A MAGNETIC FIELD. B. N. Shvilkin, M. Ya. Vasil'eva, and A. A. Zaitsev (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 844-7(1964). (In Russian)

Data are given of the condition of noise appearance in magneto-active plasma. According to the character of the noises observed, the theory of the ionic-sound and dissipative instability of the nonhomogeneous magnetized plasma can be used for their explanation. (auth)

12655 GAS VELOCITY PROBE FOR MOVING IONIZED GASES. Charles Cason (Army Missile Command, Redstone Arsenal, Ala.). J. Appl. Phys., 36: 342-7(Feb. 1965).

A direct electrical method for measuring the velocity of a flowing plasma is based upon the polarization voltage induced when a plasma flows transversely to an applied magnetic field. A method was developed to allow the estimation of certain background signals and the determination of allowable measurement currents arising from plasma and probe properties. Applications for this technique of ionized gas velocity measurements are indicated. It was found that an a-c magnetic field of the order of 5 G would give a sufficient signal to determine the gas velocity of a plasma jet as compared to a d-c field of the order of 100 G. Gas stream velocities produced by a low-power argon plasma jet were found to vary from 1000 to 3000 m/sec depending slightly on the mass flow rate and predominantly on the ambient pressure. (auth)

12656 CONSTRICTED DISCHARGES IN THE RARE GASES. I. SPECTROSCOPIC AND ELECTRICAL MEASUREMENTS. J. T. Massey and S. M. Cannon (Johns Hopkins Univ., Silver Spring, Md.). J. Appl. Phys., 36: 361-72(Feb. 1965).

A description of the visual characteristics of some constricted discharges in the rare gases using d-c, r-f, and microwave excitation is given. These discharges require power inputs of from 20 to greater than 100 w/cc. The results of a series of spectroscopic and electrical measurements made on these discharges indicate the range of plasma parameters encountered. Gas temperatures were measured using the intensity distribution of the spectra of several diatomic molecules. The gas temperature falls in the range from 2000 to 3000°K, but atomic excitation levels are not in equilibrium at this temperature. The charge density is around 10^{14}/cc from continuum intensity, line broadening, and electrical measurements. The electron energy distribution is Maxwellian with an average electron energy which falls between 1 and 2 ev. Thus, these plasmas lie between thermal and cold plasmas in their properties. The recombination process probably has contributions from both dissociative recombination and dielectronic recombination with an over-all recombination coefficient of about 2×10^{-11} cm^3/sec. (auth)

12657 CONSTRICTED DISCHARGES IN THE RARE GASES. II. ANALYSIS OF THE MACROSCOPIC PROPERTIES OF THE DISCHARGE. J. T. Massey (Johns Hopkins Univ., Silver Spring, Md.). J. Appl. Phys., 36: 373-80 (Feb. 1965).

The macroscopic properties of the rare gas constricted discharges are discussed. For the r-f excited discharge an equivalent circuit for the electrode coupling was found, comprising a capacitor with the electrode and plasma forming the plates and the discharge tube wall the dielectric. An explanation for the observed striations is advanced, based upon the existence of voltage standing waves at the plasma resonance frequency. A numerical analysis based on an energy balance indicates that these discharges should have a finite radius, in this case smaller than the discharge tube radius. It is necessary to require that the electron energy distribution be Maxwellian near the center of the discharge and that deviation from this energy distribution causes the sharp boundary observed for the heavier rare gases. For the microwave discharge it is pointed out that it is necessary to include the electromagnetic field equations in the analysis and that this requirement naturally leads to a maximum radius for a single discharge channel which is much smaller than for the r-f-excited case. This in turn leads to an explanation of the multicolumn effect observed. (auth)

12658 PROPAGATION AND INSTABILITIES OF WAVES IN BOUNDED FINITE TEMPERATURE PLASMAS. A. J. Lichtenberg and J. S. Jayson (Univ. of California, Berkeley). J. Appl. Phys., 36: 449-55(Feb. 1965).

The quasistatic analysis is used to examine propagation and instabilities of waves in a plasma in which the transverse bounds and the temperature are important. A dispersion equation is derived by use of a dielectric tensor, which is correct within the quasistatic assumption and the assumption of longitudinal velocity only. The dispersion curves have a smooth transition from the zero temperature case at long wavelengths to the unbounded finite temperature case at short wavelengths. The stop-bands which appear in the zero temperature analysis become propagating regions in the more general case. Landau-type damping is calculated; the cyclotron wave is strongly damped. The effect of the boundaries and the magnetic field on a double-humped velocity distribution is examined. The transverse boundaries are stabilizing with respect to space-charge waves, but the cyclotron interactions are strengthened. The temperature always exerts a stabilizing influence which is particularly marked for the interaction between the cyclotron waves. Curves of the limiting regions of stability, with respect to various parameters, are given, illustrating these effects. By the use of an example it is demonstrated that a moderate temperature can suppress the cyclotron instability. This result is in agreement with the experimental observation that a plasma, predicted to be unstable with respect to the cyclotron-wave interaction, was actually stable. (auth)

12659 ASYMPTOTIC PLASMA AND SHEATH REPRESENTATIONS FOR LOW-PRESSURE DISCHARGES. S. A. Self (Stanford Univ., Calif.). J. Appl. Phys., 36: 456-9 (Feb. 1965).

The collisionless plasma-sheath equation is discussed in the limit that the ratio of Debye length to discharge dimension is vanishingly small, for the cases of planar, cylindrical, and spherical symmetric discharges. Separate representations for the plasma and sheath regions are found and numerical results given for the potential profiles, ion currents, energy distributions, and floating wall potentials for two different assumptions regarding the ion generation function in each case. (auth)

12660 TWO-STREAM CYCLOTRON AND PLASMA WAVE INTERACTIONS. B. J. Maxum and A. W. Trivelpiece (Univ. of California, Berkeley). J. Appl. Phys., 36: 481-94(Feb. 1965).

Cyclotron and plasma wave interactions between drifting electron streams in a steady axial magnetic field are studied for configurations of finite transverse cross section. It is shown for the case of equal and opposite drift velocities, that there exists an instability at approximately one-half the cyclotron frequency. This instability is a consequence of the coupling between the slow space-charge wave on one stream and backward cyclotron wave on the other stream. This coupling can occur whenever the streams are of finite transverse cross section. In order

to verify some of the features of this instability, experiments in which two coaxial oppositely directed electron beams were passed between two planes were carried out for a limited range of electron drift velocity and magnetic field values. These experiments demonstrated the existence of an instability at one-half the cyclotron frequency, in agreement with the theory. It was found experimentally that at a particular stream velocity the instability could exist over a small range of magnetic field values. The upper limit of magnetic field can be explained by the assumption that nonlinearities result in a thermalization which causes the velocity spread on the electron beam to become comparable to its mean velocity. The lower limit is a consequence of the finite length of the interaction region. Although the measured signal level was much less than that expected on the basis of converting a reasonable fraction of the beam energy to r-f energy, it was found that the signals observed had a narrow frequency spread (-3 db width was 10 kc at 50 Mc). (auth)

12661 THEORY OF FLUTE INSTABILITY OF A NONHOMOGENEOUS PLASMA. V. F. Kuleshov and A. A. Rukhadze (Lebedev Inst. of Physics). Nucl. Fusion, 4: 169-78(Sept. 1964). (In Russian)

In a geometrical-optics approximation the instability of an inhomogeneous low-pressure plasma located in a gravitational field that considers effectively the curvature of the magnetic field lines is investigated. The spectrum of the low-frequency plasma potential oscillations was analyzed taking into account both gravitational and Larmor particle drifts as well as the non-potential oscillations propagating across the external magnetic field and across the particle drift. It was shown that under conditions such that the velocity of gravitational particle drift approaches Larmor drift velocity, new modes of flute-like instability appear in the plasma; this is due to a resonance buildup of Larmor drift oscillations of the plasma from a gravitational ion drift leading to plasma instability virtually at any inhomogeneity. Special attention is paid to the analysis of long-wave plasma oscillations with a wavelength exceeding the Larmor ion radius. Plasma instability with respect to long-wave oscillations is the most dangerous one. It is these oscillations that, embracing a large portion of the plasma-occupied region, can lead to breakup of the plasma as a whole. The conditions under which long-wave instabilities can develop in plasma are outlined, and the possibility of such instabilities appearing in real experimental devices (mirror devices) is discussed. It is shown that long-wave instabilities can develop in a plasma the longitudinal dimensions of which exceed transverse dimensions by $(MR/mL)^{1/2}$ times and also in a plasma in which $m/M \ll T_e/T_i \approx L/R$. In the experimental devices discussed, the first of these conditions is apparently not fulfilled, whereas the second can, generally speaking, be fulfilled. Plasma instability with respect to short-wave oscillations does not represent such a danger as it does with respect to long-wave oscillations, although such an instability can, as is shown, virtually appear at any plasma inhomogeneity and at any curvature of the magnetic field lines. Short-wave instability can lead to sharp noise increase in the plasma and as a result to the appearance of anomalously large plasma diffusion across the magnetic field. The possibility of plasma instability in devices with a negative curvature (cusped geometry) with respect to non-potential oscillations propagating across the magnetic field is also shown. (auth)

12662 INTERACTION BETWEEN A TRAVELLING ELECTROMAGNETIC FIELD AND A PLASMA. R. A. Demirkhanov, I. A. Kossy, N. I. Leontev, S. N. Lozovskii, Yu. K. Udovichenko, and T. M. Filatova (Inst. of Physics and Tech., Sukhumi, USSR). Nucl. Fusion, 4: 193-5(Sept. 1964). (In Russian)

The possibility of plasma confinement by a travelling high-frequency H wave is investigated. The experiment was performed in a toroidal pulse device. The maximal value of the high-frequency magnetic field without a plasma is 230 Oe, the frequency is 1 MHz, the phase velocity of wave propagation is 5.6×10^7 cm/sec. The high-frequency field was used for both confinement and excitation of plasma. From the distribution of the concentration of charged particles (T_e = 60,000°K) and the H_z component of the high-frequency field along the chamber cross section the gradients of plasma pressure and magnetic pressure are defined. Since the gradients are comparable in order of magnitude, concentration distribution differed perceptively from the corresponding distribution for a low level of high-frequency power when magnetic pressure is much smaller than plasma pressure. The conditions under which plasma confinement by the field of a travelling high-frequency wave is possible were studied, taking into account plasma heating. It is shown that the high-frequency magnetic field that is necessary for plasma confinement increases about proportionally to T_e, for which also charged-particle concentration must increase proportionally to $T_e^{3/2}$. For example, for $T_e = 10^{5}$°K there must be $n = 10^{16}$ cm^{-3} and $H_z = 3 \times 10^3$ Oe (for hydrogen plasma). Consequently, it is possible to satisfy the conditions for plasma confinement only at sufficiently large n and H_z. (auth)

12663 MEASUREMENT OF TURBULENT FIELDS IN A PLASMA PREPARED WITH THE AID OF MAGNETIC SOUND. I. A. Kovan, Yu. L. Moskvin, V. D. Rusanov, V. P. Smirnov, and D. A. Frank-Kamenetzkii (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 4: 227-31(Sept. 1964). (In Russian)

With the aid of a magnetic and an electric probe, turbulent fields (noise) in a magnetized plasma prepared according to the method of magneto-acoustic ionization were measured. Presence of magnetic noise with a frequency maximum in the region of 12 MHz ($\omega_i < \omega \ll \omega_e$) and low-frequency electric noise with a broad frequency spectrum increasing toward low frequencies and followed down to 80 kHz was established. The magnetic noise can, by the nature of the frequency spectrum, be identified as free magneto-acoustic vibrations of a plasma column that are excited by nonlinear interaction between the plasma and the power wave of the ionizing generator. The electric noise has both an azimuthal component characteristic of drift waves and an axial component with a phase velocity like ionic sound. Drift-wave excitation is associated with universal inhomogeneous-plasma instability, and ionic-sound excitation can be explained by both non-linear interactions of drift waves and non-stationary phenomena in the ionization process itself. (auth)

12664 EQUILIBRIUM OF A PLASMA COLUMN THAT DOES NOT POSSESS AXIAL SYMMETRY. PART II. V. D. Shafranov (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 4: 232-43(Sept. 1964). (In Russian)

Calculation of the displacement of a sharp-boundary plasma column was performed; in toroidal, figure-eight chambers that are composed of circular arcs and straight-line segments, this boundary is held in equilibrium by a longitudinal magnetic field. Dependence of the displacement of a column of round cross section on plasma pressure was obtained. A differential equation was derived for displacement $\xi(\rho)$ of magnetic surfaces with a cross section of given radius ρ without assumption of a sharp plasma boundary. If the plasma-column axis is a sufficiently smooth curve, this equation is integrated in the general case, so that the expression for the displacement is found in an explicit form. All calculations are carried out in the first approximation of the expansion over curvature. (auth)

12665 NORMAL-MODE ANALYSIS OF ELECTROSTATIC VIBRATIONS IN MAGNETO-IONIC PLASMAS. L. Gold (Martin Co., Baltimore). Nuovo Cimento (10), 35: 208-15(Jan. 1, 1965).

The basic formalism for determining the amplitudes and phases of the electrostatic normal modes dormant in a multi-component magneto-plasma is outlined. This contribution, combined with an earlier secular solution for the frequencies, completes the prescription for the normal-mode analysis of such stationary waves in plasmas. Whereas the natural resonances follow from a $(l + 1)$ by

$(l + 1)$ determinant (l being the number of distinguishable carriers), the associated phases and amplitudes of the oscillations can be shown to ultimately derive from a $(3l + 1)$ by $(3l + 1)$ determinantal system of intrinsically transcendental equations. The difficulty of extracting the individual phases and amplitudes for the effective set of N-coupled oscillators from such a set of transcendental equations is overcome by a linearization transformation that enables one to reformulate the solution in terms of an algebraic set of linear equations. Overwhelming complexities nevertheless enter so that for the present explicit solution is performed for the case $l = 1$. Other related aspects of the natural oscillations for nonpropagating modes in plasmas are discussed including the manner in which the energetics, intrinsic frequencies (cyclotron and plasma), and orientation of magnetic field, etc. influence the general behavior of the ensemble. Some related problems are briefly mentioned. (auth)

12666 THEORIES OF FAST LUMINOUS FRONTS. Raymond A. Nelson (Stanford Research Inst., Menlo Park, Calif.). Phys. Fluids, 8: 23-5(Jan. 1965).

A brief review is made of the theories of fast luminous fronts that are observed to precede shock waves in electromagnetic shock tubes. A theory proposed by Paxton and Fowler is criticized, and it is suggested that an ionization-front theory may provide a better description of such fronts. (auth)

12667 UNIFIED THEORY FOR THE LANGMUIR PROBE IN A COLLISIONLESS PLASMA. S. H. Lam (Princeton Univ., N. J.). Phys. Fluids, 8: 73-87(Jan. 1965).

An asymptotic analysis is presented of the Langmuir-probe problem in a quiescent, collisionless plasma in the limit of large body-dimension to Debye-length ratio. The structures of the electric potential distribution about spheres and cylinders are analyzed and discussed in detail. It is shown that when the probe potential is smaller than a certain well defined value, there exists no sheath adjacent to the solid surface. At large body potentials, for which a sheath is present, the electric potential distribution is given in terms of several universal functions. Master current-voltage characteristic diagrams are given which exhibit clearly the effects of all the pertinent parameters in the problem. An explicit trapped-ion criterion is presented. The general problem with an arbitrary body-dimension to Debye-length ratio is qualitatively discussed. (auth)

12668 DIPOLE RESONANCES IN A HOMOGENEOUS PLASMA IN A MAGNETIC FIELD. Peter A. Sturrock (Ames Research Center, Moffett Field, Calif. and Stanford Univ., Calif.). Phys. Fluids, 8: 88-96(Jan. 1965).

Radar observations recently made from a satellite orbiting above the ionosphere provide evidence for magnetic-field plasma resonances which may be excited and detected by a dipole. The plasma is said to be resonant, for a particular mode and frequency, if the group velocity is zero. The resonances are studied theoretically on the assumption that the dipole is of infinitesimal extent and that the plasma is excited by a charge or current impulse. There are two electromagnetic resonances at the positive-frequency roots of $\omega^2 \pm \Omega\omega - \Pi^2 = 0$, where Ω is the electron gyrofrequency and Π the electron plasma frequency, which occur at $k = 0$. There is also a resonance at $\omega = \Omega$, $k = \infty$, which can not be treated by the infinitesimal-dipole approximation. Electrostatic resonances are treated in the quasi-electrostatic approximation. The resonant frequencies are Π, $(\Pi^2 + \Omega^2)^{\frac{1}{2}}$, and $n\Omega$, $n = 2, 3, \ldots$, and $k = 0$ at resonance. The infinitesimal-dipole model breaks down for the $n = 2, 3, 4$ cyclotron harmonics, but the infinitesimal line-dipole model and a line-charge model do not. The analysis shows that the oscillations decay asymptotically as an inverse power of time. The analysis also indicates that the response would be significantly stronger than observed if measurements were made with a stationary dipole, showing that the observed duration of the resonances is due to the finite velocity of the satellite with respect to the exospheric plasma. (auth)

12669 CONSTANTS OF THE LINEARIZED MOTION OF VLASOV PLASMAS. K. M. Case (Physique Theorique et Hautes Energies, Orsay, France). Phys. Fluids, 8: 96-101(Jan. 1965).

It is shown that the constants of motion for a linearized plasma can, at least in simple cases, be characterized very much as in quantum mechanics. Thus a general constant is an arbitrary function (appropriately defined) of the transport operator while the useful constants are powers of that operator. (auth)

12670 SOME PROPERTIES OF THE TWO-STREAM INSTABILITY AT LARGE AMPLITUDES. Paul J. Kellogg (Univ. of Minnesota, Minneapolis). Phys. Fluids, 8: 102-10 (Jan. 1965).

The behavior of the electric two-stream instability for electrons streaming through ions is investigated by treating the relevant Vlasov equations as partial differential equations and integrating them on a computer. As was shown by Buneman, the growth of the instability provides a friction between the electrons and ions. It is shown that the friction is approximately proportional to the mean square electric field, and the coefficient is derived analytically and checked by the computer calculations. The friction converts the relative motion into heat; the ratio between the heating of the electrons and the ions is shown to be of the order of the square root of the mass ratio. (auth)

12671 SOME STABILIZED PLASMA EXPERIMENTS. I. Alexeff and R. V. Neidigh (Oak Ridge National Lab., Tenn.). Phys. Fluids, 8: 110-18(Jan. 1965). (ORNL-P-50)

Several combinations of magnetic cusps and mirrors are evaluated for their ability to contain cold plasma. Plasma noise, density, and decay time are measured. The plasma is considered stable if its loss rate is not greater than that permitted by multiple scattering. The cusp field with its annulus bent by adding an axially parallel uniform field gave optimum containment. A plasma containing electrons at 25 to 130 kev temperature was found to be stable in a simple magnetic mirror configuration. (auth)

12672 HYDROMAGNETIC INSTABILITY IN A STELLARATOR. Rolf M. Sinclair (Princeton Univ., N. J.), Shoichi Yoshikawa, Wynford L. Harries, Kenneth M. Young, Katherine E. Weimer, and John L. Johnson. Phys. Fluids, 8: 118-33(Jan. 1965). (MATT-262)

Stability diagrams are calculated for hydromagnetic kink instabilities in a zero-pressure plasma confined in a stellarator geometry with arbitrary mixtures of $l = 2$ and 3 multipolar helical fields and with various radial distributions of the current parallel to the confining magnetic field. The introduction of small pressure gradients increases the size of the unstable regions. Modes with small azimuthal wave number grow more rapidly than those with large m. Experimental data, obtained with the model C Stellarator, show that the plasma is macroscopically stable except for certain intervals of rotational transform. These intervals agree qualitatively with those in which the theory predicts the plasma should be unstable against the kink instability. (auth)

12673 NONLINEAR PLASMA ABSORPTION OF HIGH-FREQUENCY RADIATION. F. Albini and S. Rand (Inst. for Defense Analyses, Washington, D. C.). Phys. Fluids, 8: 134-7(Jan. 1965).

The interaction of electromagnetic radiation with a plasma was studied. The relation between the field strength and the induced current density becomes nonlinear when the electrons are accelerated to velocities in excess of the phase velocities of longitudinal electron waves. The rate of energy absorption from a radiation field was calculated, in the high-frequency limit, as a function of power input. The results are applicable when the radiation frequency exceeds the electron plasma frequency as well as the electron-ion collision frequency. It is found that the usual linear dependence of energy absorption on power input is

directly applicable when all wavelengths of electron plasma waves, emitted by a particle which oscillates in the radiation field, exceed the excursion distance of the particle from its equilibrium position. When this condition is violated, the deviations from the linearized results are logarithmic, as long as the directed velocities attained by electrons in the radiation field are small compared to the thermal electron speed. When electrons are accelerated to velocities much in excess of thermal speeds, the deviations from the linearized results become very important. (auth)

12674 RADIATIVE MODES OF A MAGNETOPLASMA SLAB. G. Halpern and G. Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids, 8: 138-42(Jan. 1965).

There exist modes of oscillation of a cold magnetoplasma slab which generate outgoing electromagnetic radiation. The dispersion equation which relates the frequency and wave number of these modes is derived. An analysis of this equation is made with emphasis on waves having phase velocity greater than light in vacuum. These waves are found to have complex frequencies due to radiation damping. For long wavelengths the radiation frequencies are near ω_p and $(\omega_p^2 + \frac{1}{4}\omega_c^2)^{\frac{1}{2}} \pm \frac{1}{2}\omega_c$, where ω_p and ω_c are the electron plasma and cyclotron frequencies, respectively. Dispersion curves are drawn for arbitrary values of applied magnetic field. The behavior of these curves is discussed in the transition to an unbounded plasma. Temperature, ion dynamics, and collisions are neglected in the analysis. (auth)

12675 COLLISION DAMPING OF ELECTRON PLASMA WAVES. S. Rand (Univ. of California, San Diego, La Jolla). Phys. Fluids, 8: 143-8(Jan. 1965).

The damping of electron plasma waves, which results from electron-ion and electron-electron collisions, was studied. A perturbation expansion about a self-consistent field is used. For long wavelengths, the principal contribution to the damping results from electron-ion collisions, with the contribution from electron-electron correlations smaller by a factor of the order $(k/k_D)^2$, where k_D is the Debye wave number. Furthermore, in a high-temperature gas, it is found that the exchange contribution to electron-electron scatters is smaller than the direct contribution by a logarithmic factor. (auth)

12676 EFFECT OF CLOSE COLLISIONS ON THE PLASMA SPECTRUM. R. L. Fante (Princeton Univ., N. J.). Phys. Fluids, 8: 149-52(Jan. 1965).

A formula is derived for the spectral density of radiation scattered by a nonequilibrium plasma, which is valid for all wave numbers. It is found that the spectrum obtained is equal to the spectrum obtained by Rosenbluth and Rostoker plus a correction representing the effects of close collisions. An order of magnitude analysis indicates that, in general, the additional term represents only a higher-order correction to the Rosenbluth-Rostoker spectrum. (auth)

12677 ELECTROMAGNETIC INSTABILITIES IN THE NONTHERMAL RELATIVISTIC PLASMA. R. N. Sudan (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 8: 153-60 (Jan. 1965).

The results of a previous investigation of growing electromagnetic waves in a gyrotropic electron plasma are extended to relativistic electron energies. If γ is the ratio of the longitudinal to the transverse electron thermal energy, then a nonrelativistic analysis predicts instabilities for both $\gamma < 1$ and $\gamma > 1$. However, for $\gamma > 1$ the phase velocity of the growing waves exceeds the velocity of light in vacuo and it is inconceivable that there are electrons that interact strongly with such a wave to give a finite growth rate. The relativistic analysis clears up this difficulty by predicting no instability for $\gamma > 1$; the error lies in the use of a Galilean rather than the correct Lorentz transformation to go from the wave frame to the frame in which the electrons are at rest. A criterion for the existence of such instabilities is given. The case of a beam of electrons with $\gamma \ll 1$ drifting at a relativistic velocity v_0 through a cold isotropic plasma is also found to be unstable. The growth rates, frequencies, and wave vectors of the unstable waves are derived. (auth)

12678 WAVE-WAVE SCATTERING OF BEAM AND PLASMA OSCILLATIONS. R. E. Aamodt and W. E. Drummond (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 8: 171-6(Jan. 1965).

The spreading of the high-frequency electron plasma oscillation energy spectrum due to nonlinear interactions with a low-frequency beam mode is calculated for a homogeneous collisionless plasma with a large external magnetic field. (auth)

12679 SCHLIEREN PHOTOGRAPHY OF A COAXIAL ACCELERATOR DISCHARGE. R. H. Lovberg (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 8: 177-85(Jan. 1965).

The plasma distribution inside a coaxial pulsed accelerator was examined by use of the schlieren photography technique. The accelerator was filled uniformly with hydrogen at 0.5 mm Hg, and the circuit externally switched. Under these conditions, the current was carried in a roughly paraboloidal shell which was followed by a dense, planar layer of plasma carrying negligible current. Polarity effects were not observed to be strong. The current in the plasma emerging from the muzzle of the acceleration retained its azimuthal symmetry and was returned to the center electrode by a well-developed pinch on the system axis. (auth)

12680 SPECTRAL LINE EMISSION FROM A TRANSIENT NONUNIFORM PLASMA. G. K. Oertel and H. R. Griem (Univ. of Maryland, College Park). Phys. Fluids, 8: 186-91(Jan. 1965).

Some effects of spatial gradients and transient behavior on spectral line radiation from impurities in a low-energy θ-pinch plasma are discussed for a case where local thermodynamic equilibrium could not be assumed. The plasma was produced and preheated by a fast capacitor bank discharge, a controlled trapped magnetic field was generated by a slower discharge through the same coil, and magnetic compression was achieved by a fast rising reverse magnetic field. Measured carbon impurity line intensities were compared to predictions on the basis of magnetohydrodynamic calculations coupled with spectroscopic theory. Large errors occur in electron temperatures derived from relative intensities of lines of successive ionization stages if the radial variation of ionization and excitation is ignored. (auth)

12681 ELECTRON-DENSITY MEASUREMENTS IN AN ELECTRON CYCLOTRON RESONANCE PLASMA. J. L. Shohet (Johns Hopkins Univ., Baltimore). Phys. Fluids, 8: 191-5(Jan. 1965).

Electron density in an electron cyclotron-heated plasma is determined by two methods. The first is by perturbation of the resonant frequency of fundamental modes of the cavity in which the plasma is contained. It is seen that for the $TE_{L\,in}$ ($L > 0$) class of modes, the resonant frequency increases, decreases, and then increases as electron density is increased. The second method utilizes microwave transmission cutoff since the steady-state density of the plasma is such that the plasma frequency of the electrons exceeds the transmitted signal frequency. (auth)

12682 OSCILLATIONS AND STABILITY OF A PLASMA JET. A. K. Sundaram (Indian Inst. of Tech., Bombay). Phys. Fluids, 8: 195-9(Jan. 1965).

The longitudinal oscillations of a cylindrical plasma jet which moves with the lines of force of an externally impressed magnetic field aligned to the jet is investigated under the usual normal mode technique. A generalized dispersion relation is derived using the appropriate boundary conditions. Formal criteria for the cylindrical vortex sheet to be stable are obtained for long and short wavelength perturbations. Certain special cases in which the conditions for stability can be simplified are discussed in detail. It is found that the cylindrical current-vortex sheet is stable to supersonic disturbances, whose wavelengths

are assumed to be large, for strong magnetic interaction and equal uniform density distribution in the stationary configuration, in either of the media. For the incompressible case, the stability conditions are rederived, and it is shown that the magnetic field stabilizes the current-vortex sheet, irrespective of the strength of the magnetic field. (auth)

12683 PLASMA MOTION AND SHOCK WAVES IN Θ-PINCH OPERATED SHOCK TUBES. Wilhelm Fucks and Johannes Czech (Technische Hochschule, Aachen). Phys. Fluids, 8: 204-5(Jan. 1965).

A study was made of the nature of the luminous front and of a discontinuity separating itself from the luminous front in electromagnetic shock tubes, using the Schlieren method. Measurements were made in He, Ar, and H at 0.5 to 100 torr. It was found that the luminous front is the edge of a moving plasma generated by the discharge in the coil region. A shock wave is separated from the plasma at a point where the ratio of shock and luminous front velocity is different from unity. If reflected, the shock interacts with the following luminous front of the plasma by a refraction process. (M.J.T.)

12684 LOSS OF PLASMA FROM CESIUM DEVICES. Robert W. Motley (Princeton Univ., N. J.). Phys. Fluids, 8: 205-7(Jan. 1965).

An experiment is reported, measuring the plasma loss rate from the Q3 device as a function of ion density and plasma temperature. Ion density was measured by a Langmuir probe for temperatures between 1970 and 2500°K, as a function of total ion flux, with and without an iris surrounding the plasma. Results are compared with previous results of theory and experiment. (M.J.T.)

12685 ABSORPTION OF RADIATION BY A PLASMA. S. Rand and F. Albini (Inst. of Defense Analyses, Washington, D. C.). Phys. Fluids, 8: 207-8(Jan. 1965).

The rate of absorption of electromagnetic energy by a plasma was computed as a function of the parameters ω/ω_p and $\hbar\omega/2KT$, where ω is the radiation frequency, ω_p is the plasma frequency, and $\frac{3}{2}$ KT is the average thermal energy. It was found that the absorption curve peak is much greater than that obtained in the classical limit, if the photon energy greatly exceeds the thermal energy. Graphs of the absorption curve peak and of the background are presented. (M.J.T.)

12686 A MOVING MIRROR LASER INTERFEROMETER FOR PLASMA DIAGNOSTICS. W. A. Kricker and W. I. B. Smith (Univ. of Sydney). Phys. Letters, 14: 102-3(Jan. 15, 1965).

A modified laser interferometer was used to distinguish between rising and falling plasma density and to assist fractional fringe counting. A peak fringe shift corresponding to an average electron density along the path of 2.7×10^{15} electrons per cm^3 was obtained for a hollow cylinder of hydrogen plasma at 100 microns pressure, using a He–Ne gas laser. A plot of the fringe number against time is shown. (L.B.S.)

12687 PLASMA DIAGNOSTICS BY NON-LINEAR RESONANT-ANGLE SCATTERING. A. Salat and A. Schlueter (Institut fur Plasmaphysik GmbH, Munich). Phys. Letters, 14: 106-7(Jan. 15, 1965).

A method for determining plasma density from geometrical properties of scattered light (e.g., light scattered at the harmonic frequency of a laser beam in a plasma) is discussed. The complete Maxwell's equations are used in describing the scattering process, and the wavelike equation is obtained by treating nonlinear terms as perturbations to the linear equation. (L.B.S.)

12688 INSTABILITIES PRODUCED IN A STATIONARY PLASMA BY AN "ALMOST CIRCULAR" ELECTRON BEAM. Jacob Neufeld and Harvel Wright (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: A1076-83(Feb. 15, 1965).

An assembly of electrons which are moving along spiral trajectories in a cold and uniform ionized medium immersed in a static magnetic field B_0 is investigated. The electrons have velocity components $v_{||}$ and $v_\perp$ which are, respectively, parallel and perpendicular to B_0. It is assumed that $v_{||} \ll v_\perp$ and, consequently, the assembly of electrons forms an almost circular beam. The interaction of a low-density almost circular electron beam with the ionized medium is examined for P (strong) and B (weak) instabilities which produce growing waves aligned with B_0. It is shown that the P instabilities give rise to four excited waves—two with frequencies in the neighborhood of the ion gyrofrequency Ω_i and the electron gyrofrequency Ω_e, and two with intermediate frequencies in the neighborhood of $\Omega_e(1-\beta_\perp^2)^{\frac{1}{2}}$ (where $B_\perp = v_\perp/c$, and c is the velocity of light). The intermediate frequency waves have the largest rate of growth and represent, therefore, the dominant instabilities. These dominant instabilities are analyzed for various values of $\beta_\perp$ in several representative plasma-beam systems. The results of this investigation are applied to the study of certain natural very-low-frequency (VLF) radiations produced by streams of charged particles which are trapped by the earth's magnetic field and which interact with the outer regions of the ionosphere (exosphere). The term VLF radiation includes both audible and subaudible frequencies. It is shown that the excited waves in the VLF range have a continuous spectral distribution which includes both whistler and magnetodynamic waves. Both whistler and magnetodynamic waves occur for any $\beta_\perp$ whether in the relativistic or nonrelativistic range. (One should exclude, however, $\beta_\perp \approx 0$, i.e., when the beam is aligned in the direction of β_0, since in such case there is no excitation of whistler waves). It is significant that for values of $\beta_\perp$ less than approximately 0.97 all the excited waves within the VLF range, both whistler and magnetodynamic waves, have the same rate of growth $|\text{Im } \delta|$ equal to $(\sqrt{2}/2)\sigma^{\frac{1}{3}}\omega_e(1-\beta^2)^{\frac{1}{3}}\beta_\perp$, where ω_e is the plasma frequency of the ionized medium, β is equal to $(v_{||}^2 + v_\perp^2)^{\frac{1}{2}}/c$, and σ is the ratio of the density of electrons in the beam to the density of the electrons in the plasma-beam medium. Thus the rate of growth $|\text{Im } \delta|$ is independent of the frequency of the excited waves within the entire VLF range under consideration. (auth)

12689 GENERALIZED STREAM INSTABILITIES IN COLD PLASMAS. Louis Gold (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 137: A1083-5(Feb. 15, 1965).

The classical double-stream theory for electrostatic instabilities in a cold plasma is generalized by a more complete treatment of the electrodynamics, whereby an analysis of electromagnetic instabilities is now afforded. Thus, consideration of wave propagation at arbitrary angles to the stream or drift motion leads to a rather involved sixth-degree algebraic dispersion formula which reflects the possible occurrence of coupled growing longitudinal and transverse waves. It is further evidenced that electromagnetic instabilities may arise even in a single-carrier system such as an electron beam. Like the special alignment where the stream and wave vectors are parallel ($U \| k$), the orthogonal case ($U \perp k$) fails to allow growing transverse waves for the single-carrier stream. However, this latter configuration does admit electromagnetic instabilities for the double-stream plasma; likely unstable regimes are indicated. A more plausible basis for interpreting radio-wave emission from plasmas emerges, and solar noise, for example, may be viewed as a direct consequence of such electromagnetic-wave instabilities. (auth)

12690 ROTATING PLASMA. B. A. Tozer (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). Proc. Inst. Elec. Engrs., (London), 112: 218-28(Jan. 1965).

Experimental and theoretical work on high-current impulsive discharges in crossed electric and magnetic fields is reviewed. Agreement between theory and experiment is considered, and attention is drawn to phenomena on which further experimentation is desirable. It is concluded, that, although good plasma containment and stability were obtained, the temperatures and rotational energies are limited by impurity radiation and losses at the end plates. The highest recorded rotational velocities are about 6×10^7

cm/s, with estimated ion temperatures corresponding to 4×10^{7}°K, under conditions where end-plate losses have been eliminated. Highest measured electron temperatures correspond to 18 ev, and energy-decay times of up to 0.3 ms were recorded. Unless impurities can be eliminated, the use of rotating-plasma devices for thermonuclear purposes must be ruled out, but there are possibilities of engineering applications for a device which changes its capacitance from picofarads to microfarads in a few microseconds. (auth)

12691 DETERMINATION OF IONIZATION RATE AND ELECTRON TEMPERATURE IN A MERCURY DISCHARGE BY A MICROWAVE METHOD. R. T. Irish and G. H. Bryant (Royal Military Coll. of Science, Shrivenham, Wilts, Eng.). Proc. Phys. Soc. (London), 84: 975-82(Dec. 1964).

By applying a small amplitude modulation to the mean current in a mercury positive column and observing the microwave reflection from the column in the region of resonance, the mercury ionization rate may be determined. The results show better agreement with theory than do probe measurements, probably because, unlike probes, the microwaves do not disturb the ion current flow to the walls. Electron temperatures may be calculated from the ionization rate using the free-fall theory proposed by Langmuir and Tonks in 1929. (auth)

12692 NUMERICAL SOLUTION FOR LOCAL EMISSION COEFFICIENTS IN AXISYMMETRIC SELF-ABSORBED SOURCES. R. W. Porter (Bendix Aviation Corp., Mishawaka, Inc.). SIAM (Soc. Ind. Appl. Math.) Rev., 6: 228-42(July 1964).

A method for determining local emission and absorption coefficients in an axisymmetric, self-absorbed source, which is applicable to laboratory arc plasma jets, is presented. In spectrometric diagnosis of arc plasma, physical and chemical properties are established through their theoretical relation to experimental line emission coefficients. These coefficients are not measured directly. The measured line intensity is a result of emitters along the spectroscopic line of sight and is affected by optical thickness, a result of physical depth and absorption in the source. (C.E.S.)

12693 PROPAGATION OF HYDROMAGNETIC SHOCK WAVE IN THE INHOMOGENEOUS MAGNETIC FIELD. Gong-liang Zhang. Ti Ch'iu Wu Li Hsueh Pao, 13: 1-10 (1964). (In Chinese)

Chisnell-Ono's method is applied to a study of the propagation of a perpendicular hydromagnetic shock wave in an inhomogeneous magnetic field. A new shock parameter, the characteristic velocity of shock waves representing the geometric mean of the shock velocities in both sides of the front, is introduced. The propagation equation obtained is greatly simplified. The equation is integrated by numerical methods for the case of strong magnetic medium, where the Alfvén velocity is much greater than the sound velocity. Three types of particle density distribution are considered: constant Alfvén velocity, uniform density, and constant ratio of density to field intensity. It is shown that when a shock wave propagates from a weak field into a strong one, its strength measured by the jump ratio of field intensity always decreases. For a medium with a constant Alfvén velocity the shock wave decays most slowly; for a medium of uniform density the shock wave attenuates most quickly; while for the constant density-field-ratio medium the attenuation rate is intermediate. In the weak shock limit, the wave amplitude is inversely proportional to the square root of the Alfvén velocity. These results are discussed in relation to a magnetic shock propagating in the earth's magnetosphere, on the assumption that the space is filled with completely ionized hydrogen plasma whose density is proportional to the field intensity, as confirmed by whistler observation from 2 to 5 earth radii. In this case, it is shown that a shock wave of initial velocity 10^{8} cm/sec at 10 earth radii excites a 60 γ field change at the earth's surface, comparable to the order of magnitude of the sudden commencement of a strong storm in the lower latitude. (auth)

12694 PLASMA ACCELERATION BY MEANS OF RADIATION. V. I. Veksler (Lebedev Inst. of Physics, Moscow), I. R. Hekker, G. A. Delone, et al. Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963, 1017-22(1964). (In Russian)

Plasma acceleration by electromagnetic fields in waveguide apparatus was discussed. Experimental results on the acceleration of hydrogen plasma with an ion density of $10^{15}-10^{16}$ were presented, and the force of the electromagnetic waves on the plasmoids was analyzed. (C.E.S.)

12695 ON TRANSIENT PROCESSES IN PLASMA. Chyuan-kong Loh (Futan Univ., [China]). Wu Li Hsueh Pao, 20: 1124-8(Nov. 1964). (In Chinese)

The macroscopic transient properties in plasma caused by a pressure gradient perpendicular to a constant magnetic field are investigated. Under the condition of zero initial flow velocity normal to the magnetic field, are investigated the instantaneous diffusion coefficient (when $\omega_{ce}\ \tau \gg 1$) $D = (2km_e c^2/e^2)(T/B^2\tau) + (kc/e)(T/B)\, e^{-(m_e/m_i)/(t/\tau)} \sin \omega_{ci} t$, where τ is the mean collision time between an ion and an electron, is obtained. (auth)

12696 STABILITY OF A TURBULENTLY HEATED PLASMA DURING ADIABATIC COMPRESSION. M. V. Babykin, P. P. Gavrin, E. K. Zavoiskii, L. I. Rudakov, V. A. Skoryupin. Zh. Eksperim. i Teor. Fiz., 47: 1631-43(Nov. 1964). (In Russian)

Results of experiments on adiabatic compression of a turbulently heated plasma are presented. The peak value of the compressing magnetic field is 9 kOe, and the half-period is 2.5 msec. The plasma was found to be stable during compression as well as during expansion throughout the observation time which was ~2 msec. The electron temperature determined on basis of the bremsstrahlung radiation from the plasma was ~30 kev at a density of 2×10^{13} cm^{-3}. The upper limit for the velocity of the plasma across the magnetic field was 2 m/sec. (auth)

12697 OBSERVATION OF SHOCK WAVES IN A COLLISION-FREE PLASMA. S. P. Zagorodnikov, L. I. Rudakov, G. E. Smolkin, and G. V. Sholin. Zh. Eksperim. i Teor. Fiz., 47: 1717-20(Nov. 1964). (In Russian)

The properties of a strong electromagnetic wave moving across a magnetic field are studied in a rarefied plasma with a density between ~10^{11} and 10^{14} cm^{-3}. A steepening of the slope of the front of the compression wave by at least 2.5 times and the formation of a shock wave with a minimal observed front time width of 2×10^{-8} sec was observed. It is found that propagation of the expansion wave in a collision free plasma is not accompanied by shock wave formation. In this case the wave front is compressed. (auth)

12698 NONLINEAR EFFECTS OF WAVES MOVING IN STATISTICAL MEDIA. V. A. Golovko (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1765-72(Nov. 1964). (In Russian)

Propagation of stationary waves of a small but finite amplitude in unbounded media is studied on basis of the Vlasov equation. The wave wind, second harmonic, and correction to the wave frequency derived in the linear approximation are calculated. Special attention is paid to the problem of specifying the coordinate system in which the investigation is carried out. The results are applied to the case when the medium is an electron plasma. (auth)

12699 THEORY OF CHARACTERISTIC LOSSES IN THIN FILMS. Yu. A. Romanov (Gor'kii State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 47: 2119-33(Dec. 1964). (In Russian)

Energy losses experienced by a fast charged particle passing through a plasma layer are calculated by quantum theory methods. Losses due to excitation of volume and surface plasmons as well as losses due to pair collisions on the surface or inside a plasma layer are taken into account. Special attention is paid to surface plasmons which hitherto were not studied in detail. The dependence of the plasmon spectrum on the thickness in thin films condition

by the discreteness of the plasma electron momenta and also the features of the energy spectrum of surface plasmons in a plasma with diffuse boundaries are considered. (auth)

12700 NONLINEAR HIGH FREQUENCY PLASMA CONDUCTIVITY. V. P. Silin (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2254-65(Dec. 1964). (In Russian)

A nonlinear theory of conductivity of a totally ionized plasma in a strong high frequency field is developed. The time-dependent plasma conductivity due to collisions between electrons and ions is found. It is shown that due to oscillations of the absolute magnitude of the electron velocity odd multiple current harmonics may arise which result in the appearance of multiple field harmonics. The dependence of the nonlinear current on polarization and stationary magnetic field is determined. (auth)

12701 THEORY OF TURBULENCE IN A TWO-TEMPERATURE PLASMA. I. A. Akhiezer (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 2269-75(Dec. 1964). (In Russian)

Possible stationary distributions of turbulent fluctuations are studied in a plasma consisting of cold ions and hot electrons moving relative to the ions with a velocity u exceeding the velocity of two-temperature sound s. It is shown that stationary distributions of turbulent fluctuations exist in the long wave region; a stationary fluctuation distribution may not be established in the short wave range. The dependence of the amplitude and angular distribution of stationary turbulent fluctuations in an unbounded plasma on the wave vector k is investigated. It is shown that with decrease of the wave vector the square of the scalar potential fluctuation amplitude increases as k^{-3} whereas the angular distribution of the fluctuations periodically changes with variation of k. For certain values of the wave vector all turbulent waves (i.e., waves propagating at an angle θ with respect to the electron flux which is less than arc cos (s/u)) are characterized by the same amplitude irrespective of angle θ. For some other values of k almost all turbulent waves move parallel to the flux or at an angle θ = arc cos (s/u) relative to it. (auth)

12702 ELECTROMAGNETIC SHOCK WAVES AND THEIR APPLICATION FOR THE FORMATION OF SHORT PULSES. S. P. Kapitsa. p.573-7 of "Voprosy Fiziki Elementarnykh Chastits." Erevan, Publishing House of Academy of Sciences, 1963. (In Russian)

The possibility is demonstrated of using electromagnetic shock waves and operating methods based on them for obtaining high-voltage pulses of nanosecond duration for spark chambers. The propagation of an electromagnetic pulse in a nonlinear medium is considered. To give a concrete form to the analysis, the discussion is limited to the propagation of a pulse of current or voltage along a coaxial line filled with ferrite. The nonlinearity of the medium produces formally a physically impossible double valued field; instead of this field, a gap is obtained, and an electromagnetic shock wave is formed. The appearance of shock waves in gas dynamics is reviewed briefly. The velocity of propagation of the stationary gap in shock electromagnetic waves is determined, using the basic relations of electrodynamics in the region containing the gap. The structure and duration of the gap are discussed. (M.J.T.)

12703 ČERENKOV RADIATION IN A PLASMA. Hiroshi Kikuchi (Polytechnic Inst. of Brooklyn and Oxford Univ.). p.235-72 of "Proceedings of the Symposium on Quasi-Optics." Brooklyn, Polytechnic Press, 1964.

Cherenkov radiation produced by a charged particle moving along an external magnetic field in a warm collisionless plasma is investigated on the basis of a medium description, which is obtained in terms of the dielectric tensor from a Fourier transform solution of the Boltzmann equation together with Maxwell's equations. Three kinds of refractive indices—the ordinary, the extraordinary, and the plasma mode—are derived for a moving charge rather than for a plane wave, taking into account the effect of the electron temperature. This results in a new type of Cherenkov radiation for the "plasma mode" as well as for the electromagnetic modes—the ordinary and extraordinary. The Cherenkov zones are defined for the ordinary, extraordinary and plasma modes in terms of the logarithmic branch cuts in a Riemann surface with two leaves and a separate complex frequency plane, while the yield of Cherenkov radiation is represented as a sum of these branch cut integrals, which is evaluated as a residue sum by Cauchy's theorem. The radiation for the electromagnetic modes emits generally in the region $\omega^2 < \omega_p^2 + \omega_c^2$ (ω_p, ω_c = plasma and cyclotron frequency of electrons), and the radiation yield for the extraordinary mode is much greater than that for the ordinary mode, which is not emitted in certain cases. For the extraordinary mode, the resonance occurs in the vicinity of $\omega^2 = \omega_p^2 + \omega_c^2$ but with Landau damping and then the extraordinary mode also couples with the plasma mode. For the plasma mode, Cherenkov radiation is possible in the regions $\omega^2 >$ Max. ($\omega_p^2 + \omega_c^2$, $4\,\omega_c^2$), $\omega^2 <$ Min. ($\omega_p^2 + \omega_c^2$, $4\,\omega_c^2$) but without resonance and is affected more or less by Landau damping. The total energy of radiation per unit time is evaluated to be of the order of $(q^2/v^{(e)})\ln(v^{(e)2}/v_T^2)$ (q, $v^{(e)}$ = charge and velocity of an injected particle, v_T = thermal velocity of plasma electrons). In the absence of an external magnetic field, the Cherenkov radiation still exists for the plasma mode, although the radiation for the electromagnetic modes is converted to nonradiative polarization losses in the limit of vanishing magnetic field. It is shown that among these three types of waves, the extraordinary mode seems useful from the point of view of radio wave generation. (auth)

12704 FURTHER CONSIDERATIONS OF THE USE OF FABRY-PEROT RESONATORS IN MICROWAVE PLASMA DIAGNOSTICS. D. H. Auston, R. I. Primich, and R. A. Hayami (General Motors Corp., Santa Barbara, Calif.). p.273-304 of "Proceedings of the Symposium on Quasi-Optics." Brooklyn, Polytechnic Press, 1964.

Experimental and theoretical studies on the field structure and the interaction of plasma within Fabry-Perot resonators suitable for microwave plasma diagnostics are discussed. The experimental work was carried out at approximately 70 gc with spherical resonator plates. Various properties such as the Q, the focal plane field distribution for various modes, and the diffraction losses were investigated as a function of plate spacing and plate shapes. The spacing was varied from confocal to concentric for solid circular plates, perforated circular plates, and solid rectangular plates. An optimum spacing for plasma diagnostics was found at slightly less than concentric. Here, maximum Q, a dominant mode spot size slightly larger than a wavelength, and diffraction losses comparable to the confocal resonator are obtained. As the concentric spacing is approached, the Q decreases rapidly and the diffraction losses increase rapidly, and at the same time lobes appear in the dominant mode focal field distribution. In the case of solid circular plates, the higher-order modes were investigated in some detail and the traditional "bulls eye," or Fresnel ring, pattern was identified. Measurements on rectangular plate resonators are currently in progress and some higher-order mode data will be presented. In the theoretical studies, the scalar diffraction theory developed elsewhere was found to be reasonably satisfactory provided that the spacing is not too nearly concentric. Efforts were concentrated on the concentric spacing. An approximate scalar theory was developed which confirms the essential features noted in experiments: that is, a small spot size and the existence of side lobes in the focal plane field distribution. An approximate theoretical analysis which indicates that the higher-order modes may be used to probe plasma variations in the focal plane is also discussed. (auth)

12705 MICROWAVE TECHNIQUES FOR THE STUDY OF UHF WAVE-PLASMA INTERACTIONS—PLASMA DIAGNOSTICS. T. Consoli, D. Lepechinsky, F. Parlange, and M. Cadart (Centre d'Etudes Nucleaires, Saclay,

France). p.305-31 of "Proceedings of the Symposium on Quasi-Optics." Brooklyn, Polytechnic Press, 1964.

Problems of applying microwave techniques to plasma diagnostics are discussed. Some fundamentals of the theory of propagation of electromagnetic waves in an ionized medium are reviewed. Theoretical relations are then developed for transverse and longitudinal propagation in hot and cold plasmas. Microwave experimental methods developed for transverse and longitudinal propagation and particularly right-hand wave propagation (guided and free propagation using optical techniques such as metal and dielectric lenses and antennas, grid separators, oversize guides, etc.) are then described. The experimental results obtained in the exploration of the propagation regions; in the studies of the effects associated with the circularly polarized right-hand wave propagation; and in two applications (heating and acceleration) of the "whistler-mode field" are also reviewed. (auth)

12706 ADVANCED PLASMA THEORY. Course XXV of Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy, July 9-21, 1962. M. N. Rosenbluth, ed. New York, Academic Press, 1964. 276p.

Separate abstracts were prepared for the ten papers included. (D.C.W.)

For abstracts of individual papers see: 11857, 12707, 12708, 12709, 12710, 12711, 12712, 12713, 12714, and 12715.

12707 KINETIC THEORY OF PLASMA. W. B. Thompson (Atomic Energy Research Establishment, Abingdon, Berks, Eng.). p.1-53 of "Advanced Plasma Theory." New York, Academic Press, 1964. (CLM-P-18)

The kinetic theory of plasma is reviewed. The hydrodynamic equations are derived from the Boltzmann equation, and methods for solving the Boltzmann equation are outlined starting with some simple representations of a simple gas, including the mean-free-time theory, and proceeding to consideration of ionized gas in a magnetic field. The transport coefficients are derived; and the correct form of the transport equation is investigated with consideration of small-angle scattering, the Fokker-Planck equation, the Vlasov equation, the power spectrum, and long-range correlations. (D.C.W.)

12708 GENERAL STABILITY THEORY IN PLASMA PHYSICS. Russel Kulsrud (Princeton Univ., N. J.). p.54-96 of "Advanced Plasma Theory." New York, Academic Press, 1964.

The fluid, adiabatic, and double adiabatic theories are reviewed. For each theory, the basic equations are derived, and static equilibrium is treated. The linearized equations for small motions about equilibrium are then derived; and an energy principle is obtained, which gives a necessary and sufficient condition for the stability of all the small motions. (D.C.W.)

12709 GAS DISCHARGE THEORY. G. Ecker (Universität, Bonn). p.97-136 of "Advanced Plasma Theory." New York, Academic Press, 1964.

An analysis of the electrode regions of the arc discharge and of the collision-dominated cylindrical plasma column is presented. The effects of magnetic fields are considered. (D.C.W.)

12710 TOPICS IN MICROINSTABILITIES. M. N. Rosenbluth (General Atomic Div., General Dynamics Corp., San Diego, Calif. and Univ. of California, San Diego, La Jolla). p.137-58 of "Advanced Plasma Theory." New York, Academic Press, 1964.

A brief survey of instabilities associated with the microscopic equations for the plasma is presented. The two-stream instability is investigated for the cases of plasma with and without magnetic fields. The stability of a simple magnetic confinement arrangement with respect to microinstabilities is also considered. (D.C.W.)

12711 INSTABILITIES DUE TO FINITE RESISTIVITY OR FINITE CURRENT-CARRIER MASS. H. P. Furth (Univ. of California, Livermore). p.159-79 of "Advanced Plasma Theory." New York, Academic Press, 1964.

An analysis of instabilities due to finite conductivity is presented. Equations are derived for the plane resistive current layer in the incompressible hydromagnetic approximation. A dispersion relation is obtained for high but finite conductivity that describes purely growing modes. An interchange mode driven by a gravitational field perpendicular to the plane layer is discussed. Instabilities due to finite current-carrier mass are also briefly treated. Similarities between hydromagnetic instabilities due to finite conductivity and instabilities of the collisionless sheet-pinch type are noted. (D.C.W.)

12712 NONLINEAR THEORY OF ELECTROSTATIC WAVES IN PLASMAS. P. A. Sturrock (Stanford Univ., Calif.). p.180-213 of "Advanced Plasma Theory." New York, Academic Press, 1964.

A brief account is presented of some approaches to the nonlinear theory of waves in plasma. The "fairly-small-amplitude" approximation in which the nonlinear terms of the wave equations are regarded as small in comparison with linear terms and their effects are treated by a perturbation technique is treated more fully. Only oscillations in uniform plasmas free from magnetic fields are considered. (D.C.W.)

12713 EQUILIBRIUM AND STABILITY OF TOROIDAL SYSTEMS IN MAGNETOHYDRODYNAMICS IN THE VICINITY OF A MAGNETIC AXIS. C. Mercier (EURATOM-C.E.A., Fontenay-aux-Roses, France). p.214-33 of "Advanced Plasma Theory." New York, Academic Press, 1964. (In French)

An analysis is presented of equilibrium and stability near the magnetic axis in toroidal systems. Applications to specific plasma containment devices are considered. (D.C.W.)

12714 BOUNDARY LAYER PROBLEMS IN PLASMA PHYSICS. B. Bertotti (EURATOM-C.N.E.N., Frascati, Italy). p.234-51 of "Advanced Plasma Theory." New York, Academic Press, 1964.

A general method for solution of boundary layer problems is outlined. Ionization near a discharge tube wall and electrostatic probes in discharges and strong magnetic fields are treated as examples. (D.C.W.)

12715 THE GYRATION OF A CHARGED PARTICLE. M. Kruskal (Princeton Univ., N. J.). p.260-6 of "Advanced Plasma Theory." New York, Academic Press, 1964.

The constancy to all orders of the adiabatic invariant (magnetic moment) of a charged particle spiraling in a magnetic field is established. (D.C.W.)

12716 ON THE MEASUREMENT OF CONDUCTIVITY OF WEAKLY IONIZED PLASMA BY HIGH FREQUENCY PROBES. Th. Moulin and J. Massé (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux, France). 17p. (CONF-640701-94). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The impedance of a short coil in the presence of a conductor medium was calculated using an approximation solution valid when the magnetic Reynolds number is very small. The effects of parasitic capacities were considered. Saline solutions were used to calibrate the probes and to verify the theoretical relations established. The electric conductivity of a jet of hot air from an arc plasma was measured with the experimental device described in order to verify the theoretical conclusions derived. (J.S.R.)

12717 DISTRIBUTION FUNCTION AND ELECTRON DENSITY OF A NONEQUILIBRIUM THERMODYNAMIC PLASMA. Y. Archambault and N. Cuenca (C.S.F.—C.E.P.E.C., Orsay, France). 12p. (CONF-640701-09). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The totality of inelastic and elastic collisions occurring in a conversion plasma, capable of modifying the distribu-

tion of electron velocities, was examined. The distribution was found to be Maxwellian because of electron-electron collisions at low energy and inelastic collisions at high energy corresponding to optically dense transitions. The electron density resulting from an ionization-recombination equilibrium was then calculated. It is shown on a numerical example that the electron densities calculated as a function of the electron temperature are less, by several orders of magnitude at low temperatures, than those predicted by the Saha law. (J.S.R.)

12718 RESISTIVITY OF COLLOIDAL PLASMAS. F. Dennery (Société l'Air Liquide, Paris). 11p. (CONF-640701-67). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The properties of a gaseous plasma (electromagnetic characteristics, characteristic induction, and cross section of electron collision) are defined in order to determine the characteristics of a colloidal plasma. The calculations are applied to a quantitative study of a baryte (BaO) plasma. (J.S.R.)

12719 STUDY OF INSTABILITIES AND TRANSITION TO TURBULENCE IN A LINEAR HALL ACCELERATOR. R. V. Hess, J. Burlock, B. Sidney, P. Brockman, and R. H. Weinstein (Langley Research Center, Hampton, Va.). 29p. (CONF-542-8)

From 5th Symposium of the Engineering Aspects of Magnetohydrodynamics, Cambridge, Mass., Apr. 1964.

Instabilities and transition to plasma turbulence were studied for a linear Hall accelerator with applied axial electric field and a radial magnetic field. Special emphasis was given to the range of operating conditions where the mean free path ranged from values smaller to values of the order or larger than the dominating wavelength of the instability and on the effect on transition to turbulence. The data presented were taken at 8 and 30μ Hg in argon. The change in spectrum of voltage oscillations with magnetic field and pressure is discussed. Criteria were established for transition to turbulence. Possible instability mechanisms were considered. (M.C.G.)

12720 STUDY ON THE LIMITATIONS OF THE CURRENT DENSITY IN THE VICINITY OF AN ELECTRODE. A. Bekiarian (Electricite de France, Paris). 7p. (CONF-640701-110). (In French)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Current-voltage characteristics were studied using an argon jet at 2700°K and slightly ionized by seeding with a mixture of Na and K. One of the electrodes was Pt with a variable potential and temperature and the other electrode was the walls of the channel carrying the jet. The current-voltage characteristics were measured as a function of the temperature of the W electrode and the seeding of the gas. The order of magnitude of the electrode temperatures necessary to obtain desired current densities with an average seeding rate was determined. To obtain higher current densities at the same temperatures it is necessary to have a relatively sharp potential drop in the vicinity of the cathode to maintain a discharge phenomenon. (J.S.R.)

12721 A-C TRAVELLING WAVE MAGNETIC FIELD-PLASMA STREAM INTERACTIONS IN THE CHARGE EXCHANGE REGIME. M. Lessen, J. A. Fox, C. S. Cook, R. A. Ellson, and L. Selke (Univ. of Rochester, N. Y.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/ENER-4, 8p. $1.00. (CONF-763-12)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The fundamental research area is concerned with the interaction of a traveling magnetic field with a plasma stream. The experiment employs a circular gas annulus surrounded by a coil to which multiphase alternating current is applied. By surrounding the coil with a low-reluctance magnetic material and providing a core of the same material, the traveling magnetic field is essentially radial. This combination provides current loops around the annulus and this current, interacting with the magnetic field, accelerates the plasma in an axial direction. Analytical studies of the experiment were made. Several basic research areas have developed that are being investigated experimentally and analytically to aid in explaining the phenomena observed. These include plasma sources due to field interaction and glow discharges. The studies are being carried out in a region of rarefied gas pressures of from 1 to 50 microns. At such low pressures the microscopic inelastic collisions of charged and neutral particles are believed to be more important than scattering collisions. This effect is considered in both the physical experiment and the analytical part of the research. (auth)

Shielding

Refer also to abstracts 11327, 11423, 11428, 11805, and 11972.

12722 (AD-422861) A MATHEMATICAL DERIVATION OF CONTOUR LINES FOR CONSTANT ALBEDO OF GAMMA RAYS ON CONCRETE. C. M. Huddleston and N. F. Shoemaker (Naval Civil Engineering Lab., Port Hueneme, Calif.). [1963]. 16p. (TN-539). $1.60(OTS).

The differential dose albedo of gamma rays on concrete depends on the energy of the incident gamma radiation, the polar angle of incidence, and the polar and azimuthal angles of backscatter. A mathematical method is developed to derive iso-albedic contours, i.e., contour lines on the surface of a hemisphere where backscattered radiation dose will be constant, when the angle of incidence is fixed and the point at which scattering occurs is at the center of the hemisphere. Graphs are presented showing iso-albedic contours for gamma radiation from Co-60 and Cs-137, incident at polar angles with cosines: 1.00, 0.75, 0.50, 0.25, and 0.10. (auth)

12723 (AE-166) THE TRANSMISSION OF THERMAL AND FAST NEUTRONS IN AIR-FILLED ANNULAR DUCTS THROUGH SLABS OF IRON AND HEAVY WATER. J. Nilsson and R. Sandlin (Aktiebolaget Atomenergi, Stockholm). Dec. 1964. 34p. Dep.(mn).

An investigation has been carried out concerning the transmission of thermal and fast neutrons in air-filled annular ducts through laminated Fe–D_2O shields. Measurements have been made with annular air gaps of 0.5, 1.0, 1.5, and 2.0 cm, at a duct length of half a meter. The neutron fluxes were determined with a foil activation technique. The thermal flux was theoretically and experimentally divided into three components, a streaming, a leakage, and an albedo component. The fast flux was similarly divided into a streaming component and a "leakage" component. A calculational model to predict the components was then developed and fitted to the data obtained by experiments. This model for prediction of neutron attenuation in ducted configurations may be applied to straight annular ducts of arbitrary dimensions and material configurations but is especially designed for the problems met with in short ducts. (auth)

12724 (NAA-SR-Memo-10584) RESULTS OF THE ANALYSIS OF EXPERIMENTS ON FAST NEUTRON TRANSMISSION IN LiH. R. S. Hubner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 4, 1964. Contract AT-11-1-GEN-8. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The results of the analysis of the ORNL Tower Shielding experiments on fast neutron transmission through lithium hydride slabs are presented and compared to the experimental data. Satisfactory agreement in the scattered dose is noted in all but the 30 inch thickness. (auth)

12725 (WAPD-TM-481) SNUG — A MONTE CARLO SHIELD DESIGN PROGRAM FOR THE PHILCO-2000 COMPUTER. N. D. Cook (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 1964.

Contract AT-11-1-GEN-14. 63p. Dep.(mn); $3.00(cy), 2(mn) OTS.

SNUG is a two-dimensional Monte Carlo shield design program which estimates fast neutron dose rates over the surface of a rectangular or cylindrical shield volume. The program primarily is designed to treat situations in which a significant fraction of the dose rate is caused by the relatively few neutrons which scatter through voids penetrating the shield array. Dose rates for up to eight similar shield configurations can be estimated simultaneously. The program can be run only on a 32K Philco-2000 digital computer. (auth)

12726 GEOMETRICAL ATTENUATION OF PARTICLE STREAMING IN ANNULAR AND ORDINARY DUCTS. Jan Nilsson (Aktiebolaget Atomenergi, Studsvik, Sweden). Nukleonik, 6: 285-7(Oct. 1964).

Current annular and ordinary duct formulas were generalized with respect to the angular source distribution function, which was put proportional to an arbitrary non-negative power of cosine of the emission angle. Each of these generalized formulas is shown to be a special solution of a generally derived "attenuation-integral." The frequently used formula approximating streaming attenuation in a straight annular duct was found to overestimate, in general, the average flux at the duct end even at large distances. An expression considered more correct and slightly simplified was derived analytically for the average flux and a comparison was made between the two expressions. (auth)

12727 GAMMA-RAY ABSORPTION COEFFICIENTS. R. C. Murty (Univ. of Western Ontario, London, Can.). Proc. Phys. Soc. (London), 84: 1032-4(Dec. 1964).

The experimental and theoretical values of scattering cross sections of gamma radiation, reported by Lakshminarayana and Jnanananda in 1961, were extended to cover a wider range of atomic numbers and photon energies. (auth)

12728 THE PROBLEM OF THE PENETRATION OF ELECTRONS THROUGH SOLIDS. A. Ya. Vyatskin, A. N. Pilyankevich, and V. V. Trunev (Leningrad Inst. of Precision Mechanics and Optics). Soviet Phys.-Solid State (English Transl.), 6: 1230-1(Nov. 1964). Translated from Fiz. Tverd. Tela, 6: 1563-5(May 1964).

Electron penetration of thin films of Al, Au, and Cu at 4 to 30 kev was measured. A previously-proposed empirical expression for the relative integral penetration factor (the ratio of electron current through the film to initial current) is revised; the exponent in this expression is found to be a function of atomic number. (M.J.T.)

REACTOR TECHNOLOGY

General

12729 (EACRP-U-17) FIRST BIENNIAL REPORT OF THE ACTIVITIES OF THE EUROPEAN AMERICAN COMMITTEE ON REACTOR PHYSICS. B. I. Spinrad and R. W. Meier (European Nuclear Energy Agency, Paris and European-American Committee on Reactor Physics). June 1964. 31p. Dep.(mn).

The activities of the committee are summarized including comments concerning the status and accomplishments of the committee at the end of the period. Information is included on committee initial formation and on functions and organization. The committee was concerned with heavy water lattice physics, lattice evaluation, thermal reactor neutron spectra, thermal reactor burnup physics, criticality predictions, irradiation experiments, nuclear data, computer codes, detector standardization, and critical experiments. (J.R.D.)

12730 (STL-372-10) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report for Period Ending September 30, 1964. C. T. Molloy, L. G. Neal, L. B. Wentz, R. W. Wright, and S. M. Zivi (Thompson Ramo Wooldridge Inc. TRW Space Technology Labs., Redondo Beach, Calif.). Oct. 30, 1964. Contract AT(04-3)-372. 58p. Dep.(mn); $3.00(cy), 2(mn) OTS.

New data were acquired in the KEWB capsule experiment and in a laboratory experiment on thermal pressure generation in water. These sets of data are related to each other and to the destructive pressure pulses in the Borax I and SPERT ID reactors. An analysis of these results is presented along with analysis of the flow and pressure fields surrounding spherical bubbles growing in the neighborhood of a wall. Studies of hydrodynamic instability models were continued. A summary of slip ratio models, an important component of the instability models, is included. (J.R.D.)

12731 SAFEGUARDS REPORTS AND SELECTED READING. J. R. Buchanan. Nucl. Safety, 6: No. 1, 108-9 (1964).

Recently issued safeguards reports and selected literature pertaining to hazards of reactors are listed. (12 references) (M.C.G.)

12732 ELEMENTARY NUCLEAR REACTOR THEORY. F. Motte and J. Debrue (C.E.N.-S.C.K., Mol, Belg.). p.755-803 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

The various radiations occurring in a reactor are discussed, and appropriate detection methods are reviewed. The main characteristics of a reactor medium are considered from the point of view of radiations. Classification of the neutrons per energy groups particularized by a dominant type of interaction with matter and with an energy balance of the secondary radiation originating in these interactions is discussed. Neutron detection techniques and techniques for measuring the heat development by energy release are discussed. Data on the BR-2 reactor are presented. (M.C.G.)

12733 NUCLEAR REACTOR KINETICS. Milton Ash. New York, McGraw-Hill Book Co., 1965. 415p. $19.50.

A survey of reactor kinetics is presented with emphasis on the mathematical methods. The zero-power kinetics equations are obtained in integral and integro-differential equation representations. Solutions of the kinetics equations, stability considerations, spatially dependent kinetics, and neutron wave phenomena are covered. The kinetics of some important reactor prototypes are also considered. (D.C.W.)

Auxiliaries and Components

Refer also to abstract 11737.

12734 (GA-5800) SUMMARY STATUS OF THE PRESTRESSED CONCRETE REACTOR STRUCTURE PROGRAM. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 3, 1964. Contract AT(04-3)-167. 80p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The technical considerations involved in the prestressed concrete reactor structure (PCRS) concept are reviewed. The problems include analysis and design for mechanical and thermal stresses, structural problems, thermal problems, and safety. Previous development work on PCRS in U.S.A. and other countries are reviewed. A detailed account is given of the General Atomic PCRS program. Analytical methods development, design development, development testing, and control of vessel temperature are covered. (D.L.C.)

12735 (SWRI-1228-42) EVALUATION OF THE SERVICEABILITY OF THE ELK RIVER REACTOR PRESSURE VESSEL. Progress Report No. 8, August 1, 1964–September 30, 1964. Jose McDonald, Jr., and Paul D. Watson (Southwest Research Inst., San Antonio). Nov. 2, 1964. Contract AT(11-1)-1228. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The serviceability of the pressure vessel for the Elk River Power Reactor is being analyzed by determining the effects of fabrication history, dissimilar weld metallurgy and geometry, and irradiation on the nil-ductility transition temperature and fatigue properties of the completed vessel. Constant-load low-cycle uniaxial fatigue curves were developed for A302-B steel in the as-received condition and in the cold strained and stress relieved condition. The fatigue strength of A302-B steel strained at 600°F and stress relieved is determined. The constant-load low-cycle uniaxial fatigue properties of A105-II steel were determined. Constant-load low-cycle uniaxial fatigue curves were developed for dissimilar welds simulating the ERR vessel 16-in. nozzle dissimilar welds (as-welded condition) and 8-in. nozzle dissimilar welds (stress relieved). Charpy V-notch impact tests were completed on the as-forged A105-II steel and as-received A302-B steel. (N.W.R.)

12736 (TID-20583) LEAKAGE CHARACTERISTICS OF STEEL CONTAINMENT VESSELS AND THE ANALYSIS OF LEAKAGE RATE DETERMINATIONS. R. R. Maccary, J. J. DiNunno, A. B. Holt, and G. A. Arlotto (Division of Safety Standards, AEC). May 1964. 112p. Dep.; $4.00 (OTS).

The principal sources of leakage in reactor containment structures are described, and the variables controlling leakage behavior in such structures are discussed. The interpretation and use of leakage-rate test data to predict leakage behavior under accident conditions are discussed. Finally, uncertainties and inaccuracies in leakage-rate test results are considered. (D.L.C.)

12737 OUT-OF-PILE INSTALLATIONS FOR TECHNOLOGICAL TESTS ON NUCLEAR FUELS. R. Fuhrmann, R. Sifferlen, and A. Saulnier. Energie Nucl., 6: 355-64 (Sept.-Oct. 1964). (In French)

A fuel element of the E.D.F. nuclear power stations is made up of a U-Mo alloy cylindrical tube, closed at both ends, enclosed in a tight can of Mg-Zr alloy, and centered in a cylindric graphite jacket. The EDF_3 reactor has more than 40,000 fuel elements of this nature, constituting a U charge of more than 400 tons. In the channels of the reactor, the fuel elements are raised to about 590°C at the hottest point, and at this temperature, it is important that the fuel tube resist a pressure of 25 bars of cooling gas without collapsing and that the canned and jacketed element

is not grossly deformed under the effect of a gaseous flux of 3.5 kg.s^{-1}. Furnaces and out-of-pile testing loops having the same arrangement of channels and the same temperature, pressure and flow, were built in order to insure that the fuel element prototypes behave in a manner which offers, at least outside the pile, total guarantee of their reliability. (auth)

12738 STEADY-STATE TEMPERATURE SOLUTION FOR A HEAT-GENERATING CIRCULAR CYLINDER COOLED BY A RING OF HOLES. J. C. Rowley and J. B. Payne (Los Alamos Scientific Lab., N. Mex.). J. Heat Transfer, 86: 531-6(Nov. 1964).

A series solution is presented to the heat-conduction equation for a heat-generating circular cylinder pierced axially by a ring of equal holes spaced uniformly on a concentric circle. The solution is based upon a class of potential functions previously defined by Howland. Typical nondimensional curves for peak and average temperatures and optimum location of the ring of holes for uniform convective cooling are presented. In addition, some shape factors or conductances for the geometry are given. (auth)

12739 THE DIGITAL REACTOR PERIOD METER. C. H. Vincent (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Instr. Methods, 31: 345-6(Dec. 11, 1964).

The two appreciable sources of error of a previously developed digital reactor period meter — statistical error and deadtime error — are considered. A calculation is given enabling the magnitude of the deadtime error to be assessed. A method is outlined of providing a very accurate simultaneous logarithmic rate display using the digital period meter. (M.J.T.)

12740 EXPERIENCE WITH CONTROL-ROD SYSTEMS AT LICENSED REACTOR FACILITIES. L. I. Cobb. Nucl. Safety, 6: No. 1, 49-54(1964).

The ways in which control-rod systems have performed their safety functions in operating reactors are discussed. Two distinct but interdependent capabilities are required: the ability of a system to shut down a reactor promptly when a condition arises that could damage the reactor and the ability to limit the rate of reactivity addition so that fuel temperature increases do not exceed the heat-transfer capability of the reactor cooling system. Four types of problems are described: stuck rods that delayed scrams, difficulties with latching and control mechanisms, instrument circuit problems, and materials problems. (M.C.G.)

12741 EMERGENCY AND SHUTDOWN COOLING SYSTEMS IN REACTORS. W. D. Brown. Nucl. Safety, 6: No. 1, 54-6(1964).

Provisions for cooling reactors under emergency and shutdown conditions are reviewed. Design data for the emergency and shutdown cooling systems of the Big Rock Point, NSA Plum Brook, BONUS, La Crosse, and Experimental Gas Cooled reactors are presented. All these reactors have independent emergency cooling systems, except the EGCR, which uses the main-coolant-system heat exchangers, although a shutdown condenser is provided for the steam system. (M.C.G.)

12742 FLOW STABILITY IN LARGE VERTICAL STEAM GENERATORS. A. N. Nahavandi and R. F. Von Hollen (Westinghouse Electric Corp., Pittsburgh). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/AUT-11, 16p, $1.00. (CONF-763-41)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A general review of the technical and economic background of two-phase flow oscillations in boiling-water systems is presented. The fundamental principles of a new digital-computer analysis for predicting the occurrence of flow instability are summarized briefly. The analysis was verified experimentally and employed successfully to determine the threshold of instability for large vertical steam generators. The effects of design-parameter variation on system stability also may be evaluated. Based on these studies, a stable steam generator for a nuclear power station was designed. (auth)

12743 IMPROVEMENTS IN OR RELATING TO CHARGE MACHINES FOR NUCLEAR REACTORS. David Arthur Evans (to United Power Co. Ltd.). British Patent 972,734. Oct. 14, 1964. Filed July 5, 1962.

A reactor charge machine that is not dependent upon auxiliary equipment is patented. The machine is mounted on a wheeled structure of generally annular form in such a manner that the machine can be raised and lowered through the central hole in the structure and the structure can be rotated around the machine. The structure has a plurality of wheels mounted on parallel axles and designed to be raised and lowered in relation to the machine. In operation the machine rests upon the charge face of the reactor over a standpipe with the wheels raised clear of the surface. When the machine is to be moved, the wheeled structure is rotated around the machine until the wheels point in the desired direction of movement. The wheels are then lowered, the machine is raised clear of the face, and the whole assembly is driven in the required direction by a motor. (A.G.W.)

12744 IMPROVEMENTS IN AND RELATING TO REACTOR CORES PROVIDED WITH RODS OF FISSIONABLE MATERIAL AND SUPPORTING LATTICES FOR SAID RODS. (to Reactor Centrum Nederland). British Patent 973,137. Oct. 21, 1964. Priority date May 25, 1962, Netherlands.

An improvement in the supporting lattice for vertical rods of fissionable material extending side by side at predetermined distances from one another in certain reactor cores is patented. The improvement is intended to facilitate the mounting of supporting lattices having resiliently clamping spacer members on the rods of fissionable material and to avoid damage to the surface of the rods during the mounting of the lattices. The spacer members are arranged in two levels in such a manner that when the lattices are moved in an oblique position over the rods or the rods are moved in an oblique position through the meshes of a lattice the spacer members are easily resilient, but if the lattices and the rods are mutually positioned at right angles the spacer members are rigidly resilient. If the lattices are not attached to other parts of the reactor, it is recommended that the rods be supported by pairs of interconnected lattices, each member of the pair being a mirror image of the other. In this case the lattices of each pair are moved at oppositely oblique angles over the bunch of parallel rods, brought against each other at right angles with the rods, and rigidly fastened together by welding or clips. (A.G.W.)

12745 CONTROLLING DEVICE FOR CONTROL AND SAFETY RODS FOR NUCLEAR REACTORS. Marc Alfred (to Commissariat a l'Energie Atomique). British Patent 973,158. Oct. 21, 1964. Priority date Feb. 5, 1960, France.

The control device described is suitable for use in a pressurized water reactor installed on board ship. The device has a longitudinally movable bolt in engagement with a nut integral with the rotor of a first reluctance type electric motor. The bolt is hollow and supports the rod to be controlled by means of a spring-loaded catch controlled by the rotor of a second electric motor of the reluctance type. The two motors are arranged coaxially one above the other in a hermetically sealed housing attached to the tank of the reactor. The housing also encloses a system for indicating the position of the rod and a cooling circuit for the first motor. The first motor is fed from a rotating switch controlled by parameters that are functions of the reactivity of the reactor and may be tapped off when the reactivity is constant. The second motor is similar in construction to the first and its controls are so arranged that a break-off on the voltage supply releases the spring-loaded catch. (A.G.W.)

12746 IMPROVEMENTS IN AND RELATING TO A PERIODMETER FOR A NUCLEAR REACTOR. (to Com-

missariat a l'Energie Atomique). British Patent 973,674. Oct. 28, 1964. Priority date Aug. 11, 1961, France.

The periodmeter described consists of a neutron ionization chamber compensated for γ radiation, a logarithmic amplifier adapted to receive a current from the chamber and to supply an output voltage proportional to the logarithm of the current, and a differentiating amplifier adapted to supply a voltage proportional to the derivative with respect to time of the voltage issuing from the logarithmic amplifier. The ionization chamber and the logarithmic amplifier may be of conventional type. The periodmeter is unique in that the differentiating amplifier, which effects primarily a differentiation, is adapted to effect also an auxiliary integration that reduces fluctuations of the out-put voltage. This integration results in a response time continuously and automatically variable both in accordance with the neutron flux and the actual period of the reactor. The response time is proportional to the period of the reactor and is relatively great when the neutron power is low and relatively small when the neutron power is high. (A.G.W.)

12747 APPARATUS FOR CHECKING THE ALIGNMENT OF VERTICAL CHANNELS. Richard D. Duncan (to U. S. Atomic Energy Commission). U. S. Patent 3,165,835. Jan. 19, 1965.

An apparatus for checking the alignment or distortion of vertical channels for control or safety rods formed in stacked graphite blocks constituting the moderator of nuclear reactors is described. A target disk is lowered through a selected channel and at various levels is pushed into a certain corner of the channel, where its position with respect to a vertical line is read by means of a sighting device at the top of the graphite stack. (AEC)

Criticality Studies

Refer also to abstract 12778.

12748 (EUR-2162.e) CRE — AN IBM 7090 CODE FOR THE DETERMINATION OF REACTIVITY CHANGES AND FLUX SHAPE DUE TO CONTROL ROD INSERTION IN A REACTOR. B. Dorpema, C. Mongini-Tamagnini, and C. Ponti (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy). 1964. 41p. Dep.(mn).

CRE is a code designed for calculating the effect of complete insertion of a ring of cylindrical control rods in a cylindrical reactor. Two-group, one-dimension theory is used, with boundary condition for the fluxes to vanish at the external radius of the reactor and to have given extrapolation lengths into the rods. The extrapolation lengths can be given in input or can be calculated by the code itself in the hypothesis of black or grey rods. The output consists of k_{eff} and fluxes. If desired these last can be also plotted versus r at different angles. (auth)

12749 (EUR-2173.i) IL METODO VARIAZIONALE DI KANTOROVICH-RITZ PER RISOLVERE NUMERICAMENTE ALCUNI PROBLEMI TRIDIMENSIONALI DELLA DIFFUSIONE NEUTRONICA. (Variational Kantorovich-Ritz Method for Numerical Solution of Some Three-Dimensional Neutronic Diffusion Problems). I. Galligani (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy). 1964. 34p. Dep.(mn).

Use of the program KANT, which solves the three dimensional multi-group (up to 20 groups) diffusion equations, is explained. These diffusion equations are solved iteratively by the Gauss-Sidel method. In each "energetic group" the flux of the reactor is obtained by using a suitable minimum principle of a particular functional. The function that minimizes this functional is calculated by the Kantorovich-Ritz method. (auth)

12750 (HW-SA-3565) PULSED NEUTRON SOURCE MEASUREMENTS AND ANALYSIS OF RANDOM NOISE IN SMALL MULTIPLYING SYSTEMS. S. R. Bierman, K. L. Garlid, and R. W. Albrecht (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 19, 1964. Contract AT(45-1)-1350. 29p. (CONF-446-43). Dep.(mn); $2.00(cy), 1(mn) OTS.

American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

A comparison is presented of the use of pulsed-neutron-source and reactor-noise measurements on small plutonium systems. The use of both methods for determination of reactor dynamic characteristics is described. (T.F.H.)

12751 (PAN-534/IX-A) SPACE-ENERGY THERMAL NEUTRON DISTRIBUTION IN THE REACTOR CELL. J. Arkuszewski and T. Kulikowska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1964. 21p. Dep.

The method of calculation of the energy- and space-dependent thermal neutron flux (or density) in the reactor cylindrical cell is described. The Laguerre polynomial expansion with Amouyal-Benoist-type boundary conditions are used. The results of calculations for NORA reactor cell are given. (auth)

12752 MEASUREMENT OF LOW REACTIVITIES. PRELUDE TO OPTIMUM CONTROL OF NUCLEAR REACTORS. Thomas Stern, Jean Valat, Jean Cazemajou, and Jacky Weill. Automatisme, 9: No. 2, 46-51(Feb. 1964). (In French)

A method for the measurement of very low reactivities is described. It is a synthesis of the random excitation methods and source modulation methods in which there is a pseudorandom excitation of the source with intercorrelation between input and output. The application of the method to the start-up of reactors is discussed. (J.S.R.)

12753 EXPERIMENTAL STUDIES ON NATURAL URANIUM-LIGHT WATER EXPONENTIAL PILE. PART I. Eiichi Takeda and Yoshio Miyawaki (Tokyo Inst. of Tech.). Bull. Tokyo Inst. of Tech., Ser. B, No. 54, 1-18(Sept. 1963).

Experimental studies performed during 1960 and 1961 with the natural uranium-light water exponential pile are described. The first half of the experiments is related to the non-multiplying system, and the measured results of L and M^2 in the light water system containing various void fractions are reported. The latter half of the experiments includes measurements of the thermal utilization and the neutron life-time in the multiplying subcritical system. (auth)

12754 REACTOR FAST-NEUTRON SPECTRUM MEASUREMENT BY THRESHOLD DETECTOR ACTIVATION. PART I. Chia-shi Lin (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 95-106(Feb. 1964).

Mathematical and perturbation methods for obtaining the fast-neutron spectra of reactors from activation measurements with threshold detectors are reviewed. The merits of the different methods are indicated. (D.C.W.)

12755 APPLICATION OF ANALOG COMPUTER IN COMPUTATION OF XENON POISONING EFFECT ON A PERIODICALLY OPERATING REACTOR. Teh-li Yang. Ho Tsu K'o Hsueh, 4: 107-21(Feb. 1964).

The time variation of the iodine and xenon concentrations were calculated for an open-pool reactor in both continuous and periodic operation at several power levels. The xenon poisoning and the built-in reactivity required to compensate the poisoning were studied in detail. The computer simulation of reactor operation is described, and the results are presented in graphical and tabular form. (D.C.W.)

12756 WHY CRITICAL AND EXPONENTIAL. J. N. Crandall (E. I. du Pont & Co., Aiken, S. C.). Nucl. News, 7: No. 12, 18-22(Dec. 1964).

Critical and exponential facilities are the experimental tools of the reactor physicist. They have a wide spectrum of uses from direct mock-up studies of a proposed new reactor to pure research on neutron transport processes, but they all have in common the fact that they operate at low

power, just sufficient to give good statistics in the measurements. The critical facilities by definition must be able to support a self-sustaining nuclear chain reaction, whereas the exponential experiments merely measure the response of a subcritical test lattice to an external source of neutrons. The critical experiments are the most versatile, but the most expensive. The exponential experiments offer much lower costs and rather greater nuclear safety at some (variable) loss in accuracy. A compromise finding increasing favor is the use of substitution critical experiments. In these experiments some portion of the critical assembly is replaced by a test lattice to form a sort of internal exponential operating in an environment which can be made arbitrarily close to that of the reference reactor design. A discussion of just what can be done in these experiments, and why all three types are necessary is presented. (auth)

12757 CALCULATION OF THE "STREAMING" EFFECT OF A CAVITY RUNNING THROUGH A REACTOR BY MEANS OF INTRODUCTION OF AN IMAGINARY MEDIUM. Hans Maerkl (Siemens-Schuckertwerke AG, Eriangen, Ger.). Nukleonik, 6: 288-9(Oct. 1964). (In German)

A cavity running unbent through a reactor causes neutron losses by so-called "streaming." Neutrons, which enter the cavity at specific angles, can, without stopping, leave the reactor and lead to a reactivity loss. The results of Pershagen and Laletin were extended, and it is shown that the introduction of a suitably defined imaginary liquid in place of the cavity is equivalent to selected effective boundary conditions. In this way the cavity can be treated according to the diffusion theory. (tr-auth)

12758 ON THE BASIC EQUATIONS OF THE REACTOR KINETICS AND THEIR APPLICATION TO FAST PULSED REACTORS. Karl-Heinz Mueller (Euratom, Ispra, Italy). Nukleonik, 6: 304-7(Oct. 1964).

The general kinetic equations governing the time behavior of any reactor were derived from the Boltzmann equation. Their coefficients depend only on the reactor composition, i.e., geometrical and material data. For a reactor, of which part of the reflector moves, the kinetic equations can be solved analytically. (auth)

12759 TRANSIENT STATES OF A NUCLEAR REACTOR DURING REFUELLING. Václav Bartošek (Inst. of Nuclear Research, Prague). Tech. Dig. (Prague), 6: No. 10, 13-19(Oct. 1964).

Results are described of a study of transient states of a reactor between the start-up, when all fuel elements are fresh, and the equilibrium state, with the elements at different stages of burn-up. Relations between the neutron multiplication coefficient and the irradiation are defined. A survey of transient states is made, giving various parameters — duration of the state, radiation stability of element, burn-up of first two charges, maximum refuelling rate, and reactivity saving in first refuelling — for several transient state types: equilibrium transition, transition with delayed refuelling, variable refuelling period, combined operation, transition with constant refuelling rate and with reactivity saving, transition with constant reactivity and reactivity saving, combined transition with reactivity saving, and transition with quadratic reactivity dependence. (M.J.T.)

Fuels

Refer also to abstracts 11347 and 12492.

12760 (NP-14671) STATE OF THE NUCLEAR FUEL MARKET IN THE COMMUNITY AND THE FREE WORLD IN THE PERIOD 1963–1967. Circular No. 4. (European Atomic Energy Community). Dec. 1963. 23p. Dep.(mn).

A survey is presented of the overall outlook for the market in natural uranium and special fissile materials in the Community and in the free world. (D.L.C.)

12761 (ORNL-3737) CONTINUOUS SCANNING X-RAY ATTENUATION TECHNIQUE FOR DETERMINING FUEL INHOMOGENEITIES IN DISPERSION-CORE FUEL PLATES. B. E. Foster, S. D. Snyder, and R. W. McClung (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 25p. Dep.; $2.00(OTS).

A sophisticated technique has been developed and successfully used for high-speed homogeneity evaluation of reactor fuel plates. Industrial x-ray equipment is used as the irradiation source, while a NaI (Tl) crystal optically coupled to a photomultiplier tube serves as the radiation detector. Careful control of the operating conditions produces very accurate and reproducible results. The method uses the x-ray attenuation principle, and on recent applications the area of evaluation has been somewhat smaller than 0.007 $in.^2$. Precision mechanical X–Y scanning of the fuel plate is accomplished with longitudinal speeds of 0 to 150 in./min and horizontal indices of 0 to 5 in. in 0.0005-in. increments. The system is provided with recording capabilities for continuous quantitative data or automatic readout for a go-no-go operation. Tolerance limits are set by a series of programmed equivalent attenuation standards at the beginning of each longitudinal pass of the fuel plate through the x-ray beam. A detailed explanation is given on the techniques for fabricating the equivalent attenuation standards. (auth)

12762 (WCAP-3269-26) LEOPARD — A SPECTRUM-DEPENDENT NON-SPATIAL DEPLETION CODE FOR THE IBM-7094. R. F. Barry (Westinghouse Electric Corp. Atomic Power Division, Pittsburgh). Sept. 1963. Contract AT(30-1)-3269. 91p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The LEOPARD computer program determines fast and thermal spectra, using only basic geometry and temperature data, based on a modified MUFT-SOFOCATE model. The code optionally computes fuel depletion effects for a dimensionless reactor and recomputes the spectra before each discrete burnup step. The LEOPARD program itself is described. (auth)

12763 WHAT EFFECTS WILL THE ENTRANCE OF PRIVATE INDUSTRY HAVE ON ATOMIC FUELS? U. Hummel (Nuklear-Chemie und Metallurgie GmbH, Wolfgang, Ger.). Atomwirtschaft, 8: 473-5(Sept. 1963). (In German)

The extent to which the costs of enriched U for atomic power are lowered by private industrial developments are discussed. The costs for enriched U depends on the concentrate cost. As an example, with fresh fuel elements having a 2.5% U concentration, used fuel elements at 1.7% U concentration, a thermal effectivity level of 26.3% and an average core life of 2.67 yr, capitalized at a rate of 6.5%, it is possible that there could be some reduction in power costs of perhaps 0.34 mills/kwh, when costs are compared on the basis of past and present estimates. The reduction might be greater if the rate of capitalization were greater or the core life were more extended. These estimates are detailed in tables and figures. (TCO)

12764 NUMERICAL EQUATIONS TO STUDY THE TEMPERATURE IN FUEL PLATE OF TSING-HUA REACTOR. Pin-fu Wang (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 85-93(Feb. 1964).

Equations are derived for the temperature distribution in an aluminum-clad, enriched-uranium fuel plate in the hottest channel and section of the reactor. Numerical results are included. Operation at steady maximum power and in a reactivity excursion are considered. (D.C.W.)

12765 FUEL ELEMENT FOR LIQUID- OR GAS-COOLED HETEROGENEOUS ATOMIC REACTORS. Heinz Stehle (to Siemens-Schuckertwerke AG). German Patent 1,179,650. Oct. 15, 1964. Filed Sept. 18, 1959.

A fuel element consisting of a coated coiled wire is described. In order to obtain a rigid fuel element the fuel wire is wound on a cord and fastened to it by soldering. (Gmelin Inst.)

12766 NUCLEAR REACTOR CORE AND FUEL ASSEMBLY. Willard H. McCorkle and Harry S. Cern (to U. S. Atomic Energy Commission). U. S. Patent 3,165,448. Jan. 12, 1965.

A fuel assembly is described for a reactor with a core including a plurality of such assemblies. Each assembly includes a plurality of spaced concentric tubes, an Al thimble in the tubes, Be cylinder in the thimble, a B-Al rod in the cylinder, and cooling means. The core includes a plurality of these assemblies in a vessel which contains finely divided graphite particles. (AEC)

Power and Power-Breeder Reactors

Refer also to abstracts 11668 and 11780.

12767 (ACNP-64568) ELK RIVER REACTOR OPERATIONS ANALYSIS PROGRAM. TOPICAL REPORT, CONTROL ROD ANALYSIS, TASK 204. J. R. Fisher, C. Ho, M. N. Audi, and E. D. Kendrick (Allis-Chalmers Mfg. Co. Atomic Energy Div., Bethesda, Md.). July 1964. Contract AT(11-1)-1357. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The reactivity worths and other performance characteristics of cruciform control rods of various designs in the Elk River Power Reactor are analyzed, for boron–stainless steel, boron carbide, Ag–In–Cd alloy, and Hf rods. (T.F.H.)

12768 (AECL-2069) PROSPECTS FOR ECONOMIC NUCLEAR POWER. J. L. Gray (Atomic Energy of Canada Ltd., Chalk River, Ont.). [nd]. 18p. (CONF-641003-1) Dep.; $0.50(AECL).

From 3rd National Northern Development Conference, Edmonton, Can.

The prospect for using nuclear plants in the Canadian north does not appear to be economically practical today or in the immediate future. It may reasonably be expected, however, that the costs of such plants will eventually come down and the requirements of size may go up, and at some future time nuclear plants will be built in Northern Canada and will be supplied without difficulty by Canadian engineers and Canadian industry. Nuclear power in large sizes as baseload units in large utilities has an immediate and expanding market. (auth)

12769 (AECL-2082) STATUS REPORT ON THE WR-1 REACTOR AND PLANS FOR ITS USE IN THE AECL RESEARCH AND DEVELOPMENT PROGRAM. R. F. S. Robertson (Atomic Energy of Canada Ltd. Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). Sept. 1964. 9p. (CONF-766-2). Dep.; $0.50(AECL).

From 10th AECL Symposium on Atomic Power, Chalk River, Ont., Oct. 1964.

Design modifications, construction status, and plans for its use in the AECL research and development program are summarized. The Wr-1 is to be used primarily for testing the organic cooled concept and for testing different fuels and materials at steadily increasing ratings. (N.W.R.)

12770 (BNL-8754) THE IMPACT OF INTEGRATED MULTIPURPOSE NUCLEAR PLANTS ON THE CHEMICAL AND METALLURGICAL PROCESS INDUSTRIES. I. ELECTROCHEMONUCLEAR SYSTEMS. Meyer Steinberg (Brookhaven National Lab., Upton, N. Y.). Dec. 1964. Contract AT-30-2-GEN-16. 64p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The recent development of large nuclear sources of inexpensive electrical power makes it possible to consider the coupling of nuclear power reactors with efficient electrochemical devices for large-scale economic production of industrial chemicals. The electrochemonuclear system consists of the three basic building blocks: nuclear reactor, dc generator, and electrochemical cell. The electrochemonuclear generation of hydrogen and oxygen is of interest for the fixation of nitrogen for fertilizers, generation of liquid and gaseous carbonaceous fuels, the production of iron and steel, and the production of liquid hydrogen and oxygen for aircraft and rocket fuel. Based on a reasonable speculation of the development of low-cost, high-pressure water electrolyzers, estimates of the economics of electrochemonuclear ammonia production relative to conventional fossil fuel based plants are presented as a function of nuclear power costs. For single-purpose plants, power costs should be less than 3.7 mills/kwh to compete with coal at $6.50/ton, less than 2.4 mills/kwh to compete with $0.40/MSCF natural gas, and less than 1.7 mills/kwh to compete with $0.30/MSCF. The latter may be available as off-peak and incremental power from large nuclear power stations and from future dual-purpose nuclear power and water desalination plants. A desalinated water and fertilizer electrochemonuclear plant appears attractive. A dual-cycle, high-temperature radiation and electrochemonuclear reactor offers a highly efficient nitrogen fixation system in the future. If by-product oxygen credit is taken at $10/ton O_2, then nuclear power at 3.4 mills/kwh can compete with natural gas at $0.20/MSCF for ammonia production. At $6.00/ton O_2 credit, nuclear power should be 2.4 mills/kwh. This suggests investigation of utilizing electrochemonuclear oxygen with by-product hydrogen in the steel industry. The realization of these concepts depend on a combination of the development of low cost nuclear power, low investment electrochemical devices, and utilization of by-products. (auth)

12771 (COO-280) INSPECTION OF THE ELK RIVER CONTROL RODS, NOVEMBER 5 THROUGH 9, 1964. D. E. Simpson and W. G. Albert (Chicago Operations Office, AEC). Dec. 1964. 37p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The 13 control rods were examined by direct viewing under water and by close-up viewing of all surfaces through a periscope. No cracks, damaged rivets, or other defects which would appear to affect the integrity of the rods were observed. The boron stainless steel section of the rods were covered with a light coating of dark oxide. Localized "worm-track" indications of corrosion were observed on some rods, probably as a result of pickling or other chemical attack prior to installation of the rods. The Zircaloy spot welds of all rods exhibited a white corrosion product, and some white corrosion product was observed at the outer edges of the cruciform in the region of the Zircaloy and boron stainless steel juncture. A wavy line indication was observed near the top of one rod (No. 11) which appeared similar to a crack; it was concluded that this indication almost certainly existed prior to completion of the rod fabrication and was probably a surface defect which occurred in manufacture of the boron stainless plate. (auth)

12772 (CVNA-195) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report, July–September 1963. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Contract [AT(30-1)-2289]. 46p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The CVTR was shutdown for the major portion of the period to permit repairs to the header cavity leakage and to accomplish checkout of other equipment. A nuclear evaluation of the plant is made. Limited experimental activity is reported. (N.W.R.)

12773 (DLCS-5001064) MONTHLY OPERATING REPORT, OCTOBER 1964. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-191. 35p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Shippingport Atomic Power Station remained shutdown for modification of the Reactor Plant for Core 2 operation, overall refueling operation, and the main turbine overhaul. Routine water sampling was limited to the Coolant Charging Water and Canal Water Systems, wherein water specifications were maintained. Conditions related to radioactive contamination were normal and personnel radiation exposures were within specified limits. Phase IV work of the overall refueling operation continued throughout October. Electrical checks of the position indicator, stator power, and stator temperature cables were performed and mechanism stator vent valve

were installed. Seven tests were performed in October, four of which were completed and three remained in progress at the end of this report period. Two of the 25 minor modifications in progress were completed. (auth)

12774 (EUR-2175.f) ISOLEMENT THERMIQUE D'UN CANAL ORGEL PAR UNE LAME DE GAZ STAGNANT. (Thermal Insulation of an Orgel-Type Channel by a Stagnant Gas Film). J. Faure and E. Labarre (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 69p. Dep.(mn).

The heat transfer between a gas insulated reactor channel of the Orgel type and the moderator depends on the temperature distribution, construction materials, the average thickness of the annular gas space, its eccentricity, and the kind and the pressure of the insulating gas. The influence of these parameters on the heat transfer has been studied and thermal losses have been calculated in various experimental conditions. The temperature difference between external tube and heavy water, consequent on the above phenomenon, together with the temperature values and the area of the hot points caused by the spacers, are discussed. (auth)

12775 (EUR-2190.f) "REFERENCE DESIGN" D'UNE CENTRALE ORGEL DE 250 MWe. (A Reference Design for a 250 Orgel-Type Power Station). A. Bahbout and S. Orlowski (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 66p. Dep.(mn).

A reference design for a 250 Mwe ORGEL-type power station has been studied. Moreover, the capital investment has been evaluated and price-functions established for the various major items of equipment. Comments are made on the various basic choices such as the magnitude of the installed power, the lay-out of the reactor, the selection of core materials, the fuel management, etc. The solutions to the various design problems are recalled and commented on. The unit cost per kw installed, as well as the calculation of the fuel cycle cost, are given. The basis on which the various prices and price-functions were collected is briefly recalled. A comparison is made between some economic aspects of an ORGEL power station and those relating to other plants being built in the European Community. (auth)

12776 (EURAEC-1162) HEAT TRANSFER AND MIXING STUDIES IN A P.W.R.-REACTOR LOOP. First Quarterly Progress Report, Janurary 1, 1964–April 1, 1964. (Eindhoven, Netherlands. Technische Hogeschool). June 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 11-63-9 TEEN. 65p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The design and development of electrically heated pressurized water reactor loop for studying heat transfer and mixing are summarized. The difficulties and failures with the loop are discussed along with the first research runs made with the loop. (N.W.R.)

12777 (EURAEC-1231) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Report No. 2. (Societa Elettronucleare Nazionale, Rome). Oct. 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 101-63-RDI. 8p. Dep.(mn); $1.00(cy), 1(mn).

Design and installation of components and auxiliaries for the Garigliano Power Reactor are outlined. (T.F.H.)

12778 (GEAP-4644) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES. Ninth Quarterly and Summary Report, April 1–June 30, 1964. P. Meyer and E. Garelis (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Sept. 22, 1964. Contract AT(04-3)-189. 43p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The pulsed neutron model of Garelis-Russell for the measurement of shut-down reactivity was investigated in reflect cores in the Vallecitos Thermal Critical Assembly (TCA). The pulsed neutron source method is based upon a bare (unreflected) monoenergetic diffusion theory model and uses the complete neutron density versus time profile of a pulsed assembly to obtain the parameter $(k\beta/\ell)$. This ratio, together with the usual α gives a measure of the reactivity, i.e., $\rho = [\alpha - (k\beta/\ell)]/(k\beta/\ell)$ where ρ is in units of β, the delayed fraction. All of the measurements in the TCA were made on the minimum critical mass configuration and consequently did not exhibit the multi-core effect that is found in large power reactors. This effect was observed in large core measurements reported earlier and is discussed. It was found that the $(k\beta/\ell)$ theory yields meaningful results for reflected cores down to at least 3.5 dollars subcritical. This means that the measured values of $(k\beta/\ell)$ are unique and independent of the relative source and detector position. It was established that the $(k\beta/\ell)$ measurement eliminates the need for a separate α-delayed critical, (β/ℓ), determination, since a single measurement yields all of the necessary information. A new pulsing technique that simplifies the experimental procedure in obtaining reliable data for both the α and $(k\beta/\ell)$ measurement was experimentally verified. This technique extends the usefulness of commercially available pulsed neutron generators. (auth)

12779 (GEAP-4732) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES 10th QUARTERLY PROGRESS REPORT JULY 1–SEPTEMBER 30, 1964. E. Garelis, P. Meyer, and A. E. Waltar (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 20, 1964. Contract AT(04-3)-189. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The shutdown reactivity of an assembly is theoretically and experimentally analyzed. It is argued that a pseudo-random impulse input with a period of (1/R) seconds is equivalent to repetitively pulsing a core at R times per second. This follows simply because the auto-correlation of an idealized pseudo-random input approximates a delta function at intervals of 1/R seconds. Essentially, this is, in principle, the same as in the repetitively pulsed source method. The experimental system consists of four main components: the pulsed neutron source to provide the input; the neutron detection circuitry measuring the neutron density in the reactor, i.e. the output; the cross correlator; and the pseudo-random signal generator. Results of a study to determine the advantages of analog and digital computers for the simulation indicate the accuracies obtained in an analog computer are insufficient to be of practical value. The digital computer appears to have the required capabilities to provide useful information which may aid in the choice of cross-correlator hardware. (N.W.R.)

12780 (GEAP-4741) HIGH POWER DENSITY DEVELOPMENT PROJECT. Quarterly Progress Report No. 18, July–September 1964. R. L. Holladay, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1, 1964. Contract AT(04-3)-361. 90p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The post-irradiation examinations of fuel rods irradiated in the VBWR were continued. The irradiation of Group I and II developmental assemblies and the visual examinations of the assemblies are reported. Profile measurements of some of the fuel rods show clad ridging and ovality. Fuel-poison rods containing $UO_2-Gd_2O_3$ dispersions were inserted into several developmental assemblies. Examination of the burned-out trail cable specimen is described. Reduced data are given for the natural circulation tests run at Big Rock Point: pump trip tests, core performance tests, and control rod oscillation. Physics calculations for high power density cores are discussed briefly. A gamma scan of half of the bundles in the 84-bundle core gave good agreement between measured and calculated powers. Finally, coordination and test planning is considered. (D.L.C.)

12781 (HPR-37) SECOND CHARGE EXPERIMENTAL EQUIPMENT AT HBWR. A. Brouwers, H. P. Olson, and

O. Vappavuori (Norway. Institutt for Atomenergi. OECD Halden Reactor Prosjekt). Sept. 1964. 68p. Dep.(mn).

The experimental equipment used in the plant dynamics and stability studies with the second fuel charge at HBWR consisted of a sinusoidal reactivity oscillator, a reactivity step generator, a system to produce binary perturbations in reactivity with control rods, a system to produce sinusoidal, step or binary perturbations in primary steam flow with a control valve, and an automatic pressure control system. (auth)

12782 (PAN-542/IX) PERSPEKTYWY ROZWOJOWE REAKTORÓW SIŁOWNI BIEŁOJARSKIEJ. (Future Prospects of the Beloyarsk Power Reactors). J. Łopuszyński (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1964. 25p. Dep.

Thermal and power calculations are presented for a water-cooled graphite-moderated pressure-tube reactor (Beloyarsk type) for supercritical steam parameters. (auth)

12783 (TID-21607) HALLAM NUCLEAR POWER FACILITY MONTHLY OPERATING REPORT NO. 28, NOVEMBER 1964. (Consumers Public Power District, Lincoln, Neb.). Contract AT(11-1)-513. 59p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The reactor remained shutdown the entire month for the moderator replacement program. The removal of fuel elements and the storing of loops and generators in inert gas atmospheres are described. (D.L.C.)

12784 (UJV-1045/64) VÝPOČET FYZIKÁLNÍCH PARAMETRŮ MŘÍŽE TĚŽKOVODNÍHO REAKTORU S PŘÍRODNÍM URANEM, CHLAZENÉHO PLYNEM. ČÁST I. METODIKA VÝPOČTU MŘÍŽE. (Calculation of Physical Parameters of a Gas Cooled Heavy-Water Reactor with Natural Uranium. Part I. Method of Lattice Calculations). P. Šulc, J. Markvart, and J. Pfann (Československá Akademie Věd. Ustav Jaderného Výzkumu, Řež). [196?]. 56p. Dep.(mn).

Physics calculations of a heavy-water, gas-cooled, natural-uranium power reactor are presented. A description of calculation methods for bucklings and other necessary parameters to obtain neutron flux distribution in a multizone active core in two-group approximation is given. (auth)

12785 (WAPD-MRP-110) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, July 24–October 23, 1964. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Contract AT(11-1)-Gen-14. 102p. Dep.; $2.50(OTS).

Progress on the Shippingport Pressurized Water Reactor is reported. Topics covered include: plant modification, plant decontamination, refueling, reactor engineering, metallurgy of core materials, core operation, and reactor physics. (N.W.R.)

12786 (WCAP-2571) CONNECTICUT YANKEE BOTTOM-MOUNTED INSTRUMENTATION FEASIBILITY STUDY. H. F. Fensterer (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Feb. 1964. Contract AT(30-1)-3250. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Bottom mounted instrumentation represents a means of introducing flux measuring instruments into the core through thimbles inserted through the vessel bottom rather than through the vessel head. This method would reduce refueling time associated with in-core instrumentation to a minimum, simplify the refueling operation in general, and would not require the removal and storage of a top-mounted instrumentation structure. The thimbles are inserted into the fuel assemblies after the core is loaded and withdrawn from the core before the fuel assemblies are handled for refueling. The thinbles will accept either neutron flux sensing wires, Aeroball instrumentation systems, or miniature detectors. The study described was undertaken in order to prove the feasibility. The bottom insertion technique is concluded to be feasible. (auth)

12787 (ORNL-tr-404) PERSPECTIVES OF NUCLEAR HEATING PLANTS IN CZECHOSLOVAKIA. Jan Hulevec and Arnost Komauk. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 10-14(1964). 14p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The problem of centralized heat production is best solved by the use of nuclear fission materials. Two nuclear heating plant concepts are described in which a pressurized water reactor and two energy reactors of the D_2O-moderated, CO_2-cooled type are used, respectively. Prospective heat and electric outputs and some calculations on the cost of heat are given. (D.L.C.)

12788 (RISLEY-Trans-287) PRODUCTION OF ENERGY IN FRENCH NUCLEAR POWER STATION. (PRINCIPLES AND MATERIALS USED). (Translation). J. P. Roux and J. Hustache. [196?]. 31p. Dep.(mn); $3.60(fs), $1.13(mf) JCL.

The utilization of the heat produced by French nuclear power stations for the production of electric energy is discussed. The characteristics, general layout, heat extraction, and modifications of the Chinon reactors (EDF-1, EDF-2, and EDF-3) are described. The principal characteristic equipment of the different Chinon reactors are described and compared with conventional thermal power stations. (N.W.R.)

12789 CONSIDERATION ON THE DESIGN OF THE FAST POWER REACTOR WITH A CENTRAL BLANKET. Yoshie Ebizuka and Hiroshi Mizuta (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Tech., Ser. B, No. 54, 41-50(Sept. 1963).

A reactor system with a central blanket is discussed with regard to the restriction set by radiation damage to fuel elements and the limitation imposed by the maximum temperature in the system. It is suggested that an increase in specific power could be achieved by employing such a blanket over a limited range of reactor power for given limitations to the maximum neutron flux and the maximum fuel temperature. Another argument in favor of using a central blanket is that it is possible to achieve some increase in thermal efficiency. These appear to be promising aspects of the system for large scale power reactors. It is noted, however, that some decrease in initial breeding ratio occurs with an increase of radius of the central blanket. This may be regarded as a disadvantage of the system. In this connection, however, the breeding ratio seems to be underestimated in that, although the spectrum of neutron energy is expected to be harder due to increase in concentration of fuel in the core, this effect is not taken into consideration in the calculations. Therefore the breeding ratio would be expected to be larger, at least, in the active core. Although simplified means were used, more detailed calculations are being performed with a two dimensional multigroup method. (auth)

12790 THE PRESTRESSED CONCRETE VESSELS OF THE REACTORS OF THE ELECTRICITY OF FRANCE'S NUCLEAR POWER PLANTS. Georges Lamiral and Jean Courbon. Energie Nucl., 6: 333-46(Sept.-Oct. 1964). (In French)

A description of the French EDF3 and EDF4 power plant vessels is presented. The design of prestressed concrete vessels including working methods, efforts, thermic stresses, etc. is described. The test carried out on small scale models are also described. A paragraph is devoted to the supplementary problems which are met in the design of these vessels, especially that of the thermal protection of the prestressed concrete. After testing various solutions, pumice concrete was chosen as the thermal insulation for the vessel. The development, the properties, the tests and control, and the use of this material are described. (auth)

12791 NUCLEAR POWER STATION WITH SUPPLEMENTAL COMBUSTION OF HEAVY OIL. Atsuo Imanishi and Kiyoshi Miyagawa (Fuji Electric Mfg. Co., Ltd., Japan). Fuji Jiho, 37: 397-402(May 1964). (In Japanese)

To reduce the cost of nuclear power stations, improvement of heat consumption is an important problem as well as reduction of construction cost. A new effective method of decreasing heat consumption of nuclear power stations by using other supplemental fuel is suggested. The heat

were installed. Seven tests were performed in October, four of which were completed and three remained in progress at the end of this report period. Two of the 25 minor modifications in progress were completed. (auth)

12774 (EUR-2175.f) ISOLEMENT THERMIQUE D'UN CANAL ORGEL PAR UNE LAME DE GAZ STAGNANT. (Thermal Insulation of an Orgel-Type Channel by a Stagnant Gas Film). J. Faure and E. Labarre (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 69p. Dep.(mn).

The heat transfer between a gas insulated reactor channel of the Orgel type and the moderator depends on the temperature distribution, construction materials, the average thickness of the annular gas space, its eccentricity, and the kind and the pressure of the insulating gas. The influence of these parameters on the heat transfer has been studied and thermal losses have been calculated in various experimental conditions. The temperature difference between external tube and heavy water, consequent on the above phenomenon, together with the temperature values and the area of the hot points caused by the spacers, are discussed. (auth)

12775 (EUR-2190.f) "REFERENCE DESIGN" D'UNE CENTRALE ORGEL DE 250 MWe. (A Reference Design for a 250 Orgel-Type Power Station). A. Bahbout and S. Orlowski (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 66p. Dep.(mn).

A reference design for a 250 Mwe ORGEL-type power station has been studied. Moreover, the capital investment has been evaluated and price-functions established for the various major items of equipment. Comments are made on the various basic choices such as the magnitude of the installed power, the lay-out of the reactor, the selection of core materials, the fuel management, etc. The solutions to the various design problems are recalled and commented on. The unit cost per kw installed, as well as the calculation of the fuel cycle cost, are given. The basis on which the various prices and price-functions were collected is briefly recalled. A comparison is made between some economic aspects of an ORGEL power station and those relating to other plants being built in the European Community. (auth)

12776 (EURAEC-1162) HEAT TRANSFER AND MIXING STUDIES IN A P.W.R.-REACTOR LOOP. First Quarterly Progress Report, Janurary 1, 1964–April 1, 1964. (Eindhoven, Netherlands. Technische Hogeschool). June 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 11-63-9 TEEN. 65p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The design and development of electrically heated pressurized water reactor loop for studying heat transfer and mixing are summarized. The difficulties and failures with the loop are discussed along with the first research runs made with the loop. (N.W.R.)

12777 (EURAEC-1231) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Report No. 2. (Societa Elettronucleare Nazionale, Rome). Oct. 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 101-63-RDI. 8p. Dep.(mn); $1.00(cy), 1(mn).

Design and installation of components and auxiliaries for the Garigliano Power Reactor are outlined. (T.F.H.)

12778 (GEAP-4644) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES. Ninth Quarterly and Summary Report, April 1–June 30, 1964. P. Meyer and E. Garelis (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Sept. 22, 1964. Contract AT(04-3)-189. 43p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The pulsed neutron model of Garelis-Russell for the measurement of shut-down reactivity was investigated in reflect cores in the Vallecitos Thermal Critical Assembly (TCA). The pulsed neutron source method is based upon a bare (unreflected) monoenergetic diffusion theory model and uses the complete neutron density versus time profile of a pulsed assembly to obtain the parameter $(k\beta/\ell)$. This ratio, together with the usual α gives a measure of the reactivity, i.e., $\rho = [\alpha - (k\beta/\ell)]/(k\beta/\ell)$ where ρ is in units of β, the delayed fraction. All of the measurements in the TCA were made on the minimum critical mass configuration and consequently did not exhibit the multi-core effect that is found in large power reactors. This effect was observed in large core measurements reported earlier and is discussed. It was found that the $(k\beta/\ell)$ theory yields meaningful results for reflected cores down to at least 3.5 dollars subcritical. This means that the measured values of $(k\beta/\ell)$ are unique and independent of the relative source and detector position. It was established that the $(k\beta/\ell)$ measurement eliminates the need for a separate α-delayed critical, (β/ℓ), determination, since a single measurement yields all of the necessary information. A new pulsing technique that simplifies the experimental procedure in obtaining reliable data for both the α and $(k\beta/\ell)$ measurement was experimentally verified. This technique extends the usefulness of commercially available pulsed neutron generators. (auth)

12779 (GEAP-4732) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES 10th QUARTERLY PROGRESS REPORT JULY 1–SEPTEMBER 30, 1964. E. Garelis, P. Meyer, and A. E. Waltar (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 20, 1964. Contract AT(04-3)-189. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The shutdown reactivity of an assembly is theoretically and experimentally analyzed. It is argued that a pseudo-random impulse input with a period of (1/R) seconds is equivalent to repetitively pulsing a core at R times per second. This follows simply because the auto-correlation of an idealized pseudo-random input approximates a delta function at intervals of 1/R seconds. Essentially, this is, in principle, the same as in the repetitively pulsed source method. The experimental system consists of four main components: the pulsed neutron source to provide the input, the neutron detection circuitry measuring the neutron density in the reactor, i.e. the output; the cross correlator; and the pseudo-random signal generator. Results of a study to determine the advantages of analog and digital computers for the simulation indicate the accuracies obtained in an analog computer are insufficient to be of practical value. The digital computer appears to have the required capabilities to provide useful information which may aid in the choice of cross-correlator hardware. (N.W.R.)

12780 (GEAP-4741) HIGH POWER DENSITY DEVELOPMENT PROJECT. Quarterly Progress Report No. 18, July–September 1964. R. L. Holladay, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1, 1964. Contract AT(04-3)-361. 90p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The post-irradiation examinations of fuel rods irradiated in the VBWR were continued. The irradiation of Group I and II developmental assemblies and the visual examinations of the assemblies are reported. Profile measurements of some of the fuel rods show clad ridging and ovality. Fuel-poison rods containing $UO_2-Gd_2O_3$ dispersions were inserted into several developmental assemblies. Examination of the burned-out trail cable specimen is described. Reduced data are given for the natural circulation tests run at Big Rock Point: pump trip tests, core performance tests, and control rod oscillation. Physics calculations for high power density cores are discussed briefly. A gamma scan of half of the bundles in the 84-bundle core gave good agreement between measured and calculated powers. Finally, coordination and test planning is considered. (D.L.C.)

12781 (HPR-37) SECOND CHARGE EXPERIMENTAL EQUIPMENT AT HBWR. A. Brouwers, H. P. Olson, and

O. Vappavuori (Norway. Institutt for Atomenergi. OECD Halden Reactor Prosjekt). Sept. 1964. 68p. Dep.(mn).

The experimental equipment used in the plant dynamics and stability studies with the second fuel charge at HBWR consisted of a sinusoidal reactivity oscillator, a reactivity step generator, a system to produce binary perturbations in reactivity with control rods, a system to produce sinusoidal, step or binary perturbations in primary steam flow with a control valve, and an automatic pressure control system. (auth)

12782 (PAN-542/IX) PERSPEKTYWY ROZWOJOWE REAKTORÓW SIŁOWNI BIEŁOJARSKIEJ. (Future Prospects of the Beloyarsk Power Reactors). J. Łopuszyński (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1964. 25p. Dep.

Thermal and power calculations are presented for a water-cooled graphite-moderated pressure-tube reactor (Beloyarsk type) for supercritical steam parameters. (auth)

12783 (TID-21607) HALLAM NUCLEAR POWER FACILITY MONTHLY OPERATING REPORT NO. 28, NOVEMBER 1964. (Consumers Public Power District, Lincoln, Neb.). Contract AT(11-1)-513. 59p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The reactor remained shutdown the entire month for the moderator replacement program. The removal of fuel elements and the storing of loops and generators in inert gas atmospheres are described. (D.L.C.)

12784 (UJV-1045/64) VÝPOČET FYZIKÁLNÍCH PARAMETRŮ MŘÍŽE TĚŽKOVODNÍHO REAKTORU S PŘÍRODNÍM URANEM, CHLAZENÉHO PLYNEM. ČÁST I. METODIKA VÝPOČTU MŘÍŽE. (Calculation of Physical Parameters of a Gas Cooled Heavy-Water Reactor with Natural Uranium. Part I. Method of Lattice Calculations). P. Šulc, J. Markvart, and J. Pfann (Československá Akademie Věd. Ustav Jaderného Výzkumu, Řež). [1967]. 56p. Dep.(mn).

Physics calculations of a heavy-water, gas-cooled, natural-uranium power reactor are presented. A description of calculation methods for bucklings and other necessary parameters to obtain neutron flux distribution in a multizone active core in two-group approximation is given. (auth)

12785 (WAPD-MRP-110) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, July 24–October 23, 1964. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Contract AT(11-1)-Gen-14. 102p. Dep.; $2.50(OTS).

Progress on the Shippingport Pressurized Water Reactor is reported. Topics covered include: plant modification, plant decontamination, refueling, reactor engineering, metallurgy of core materials, core operation, and reactor physics. (N.W.R.)

12786 (WCAP-2571) CONNECTICUT YANKEE BOTTOM-MOUNTED INSTRUMENTATION FEASIBILITY STUDY. H. F. Fensterer (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Feb. 1964. Contract AT(30-1)-3250. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Bottom mounted instrumentation represents a means of introducing flux measuring instruments into the core through thimbles inserted through the vessel bottom rather than through the vessel head. This method would reduce refueling time associated with in-core instrumentation to a minimum, simplify the refueling operation in general, and would not require the removal and storage of a top-mounted instrumentation structure. The thimbles are inserted into the fuel assemblies after the core is loaded and withdrawn from the core before the fuel assemblies are handled for refueling. The thinbles will accept either neutron flux sensing wires, Aeroball instrumentation systems, or miniature detectors. The study described was undertaken in order to prove the feasibility. The bottom insertion technique is concluded to be feasible. (auth)

12787 (ORNL-tr-404) PERSPECTIVES OF NUCLEAR HEATING PLANTS IN CZECHOSLOVAKIA. Jan Hulevec and Arnost Komauk. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 10-14(1964). 14p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The problem of centralized heat production is best solved by the use of nuclear fission materials. Two nuclear heating plant concepts are described in which a pressurized water reactor and two energy reactors of the D_2O-moderated, CO_2-cooled type are used, respectively. Prospective heat and electric outputs and some calculations on the cost of heat are given. (D.L.C.)

12788 (RISLEY-Trans-287) PRODUCTION OF ENERGY IN FRENCH NUCLEAR POWER STATION. (PRINCIPLES AND MATERIALS USED). (Translation). J. P. Roux and J. Hustache. [1967]. 31p. Dep.(mn); $3.60(fs), $1.13(mf) JCL.

The utilization of the heat produced by French nuclear power stations for the production of electric energy is discussed. The characteristics, general layout, heat extraction, and modifications of the Chinon reactors (EDF-1, EDF-2, and EDF-3) are described. The principal characteristic equipment of the different Chinon reactors are described and compared with conventional thermal power stations. (N.W.R.)

12789 CONSIDERATION ON THE DESIGN OF THE FAST POWER REACTOR WITH A CENTRAL BLANKET. Yoshie Ebizuka and Hiroshi Mizuta (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Tech., Ser. B, No. 54, 41-50(Sept. 1963).

A reactor system with a central blanket is discussed with regard to the restriction set by radiation damage to fuel elements and the limitation imposed by the maximum temperature in the system. It is suggested that an increase in specific power could be achieved by employing such a blanket over a limited range of reactor power for given limitations to the maximum neutron flux and the maximum fuel temperature. Another argument in favor of using a central blanket is that it is possible to achieve some increase in thermal efficiency. These appear to be promising aspects of the system for large scale power reactors. It is noted, however, that some decrease in initial breeding ratio occurs with an increase of radius of the central blanket. This may be regarded as a disadvantage of the system. In this connection, however, the breeding ratio seems to be underestimated in that, although the spectrum of neutron energy is expected to be harder due to increase in concentration of fuel in the core, this effect is not taken into consideration in the calculations. Therefore the breeding ratio would be expected to be larger, at least, in the active core. Although simplified means were used, more detailed calculations are being performed with a two dimensional multigroup method. (auth)

12790 THE PRESTRESSED CONCRETE VESSELS OF THE REACTORS OF THE ELECTRICITY OF FRANCE'S NUCLEAR POWER PLANTS. Georges Lamiral and Jean Courbon. Energie Nucl., 6: 333-46(Sept.-Oct. 1964). (In French)

A description of the French EDF3 and EDF4 power plant vessels is presented. The design of prestressed concrete vessels including working methods, efforts, thermic stresses, etc. is described. The test carried out on small scale models are also described. A paragraph is devoted to the supplementary problems which are met in the design of these vessels, especially that of the thermal protection of the prestressed concrete. After testing various solutions, pumice concrete was chosen as the thermal insulation for the vessel. The development, the properties, the tests and control, and the use of this material are described. (auth)

12791 NUCLEAR POWER STATION WITH SUPPLEMENTAL COMBUSTION OF HEAVY OIL. Atsuo Imanishi and Kiyoshi Miyagawa (Fuji Electric Mfg. Co., Ltd., Japan). Fuji Jiho, 37: 397-402(May 1964). (In Japanese)

To reduce the cost of nuclear power stations, improvement of heat consumption is an important problem as well as reduction of construction cost. A new effective method of decreasing heat consumption of nuclear power stations by using other supplemental fuel is suggested. The heat

consumption can be reduced by using other fuel to 1,800 kcal/kwh, which is nearly equal to that of the supercritical steam power plant. (auth)

12792 DYNAMIC PROPERTIES OF A POWER STATION WITH A HEAVY WATER GAS COOLED REACTOR. Pavel Štirský (Research Inst. of Power Engineering, Prague) and Jan Huelovec. Jaderna Energie, 10: 364-72(1964). (In Czech.)

Dynamic properties of the main technological equipment of the power station and the control system, ensuring operation at the given power level of the turbo-generator are briefly described. Transients of power station provoked by the failing of the technological equipment and of the regulating system are analyzed. Results of calculation of the dynamic behavior of technological control and safety equipment are given for failures including wrong extraction of all control rods, rupture of the main tubing in the inseparable part, interruption of the power supply to the reactor itself, breakdown disconnection of one or two circulation blowers, and breakdown disconnection of the turbine. Different measurements on how to decrease and restrict the temperature shocks caused by the shutdown of the reactor are described. Dynamic properties of the power station at non-nominal output levels and its behavior in the electric power system are considered. (auth)

12793 THE BODEGA STORY. Nucl. News, 7: No. 12, 13-16(Dec. 1964).

The events and findings that led to the termination of the Bodega Bay Power Reactor project are outlined. Local opposition to the Bodega project is summarized. The greatest amount of controversy centered upon the geology of the area and the possibilities of earthquakes. The Bodega site is 1¼ miles from the San Andreas Fault and about 1000 feet from the western edge of the fault zone. It was concluded that Bodega Head is not a suitable location for the proposed nuclear power plant at the present state of knowledge due to unproven and perhaps unprovable design measures to cope with forces produced by several feet of sheer ground movement under a reactor building in a severe earthquake. (C.E.S.)

12794 ATMOSPHERIC POLLUTION FROM NUCLEAR POWER PLANTS. J. W. Flora and G. H. Smith. Nucl. Safety, 6: No. 1, 81-7(1964).

Radioactive polution of the atmosphere by nuclear power plants was studied to ascertain whether any condition exists at the facility that may be detrimental to the health and safety of the public. Sources of radioactive effluents, measures taken to limit release of air contaminants, bases for commission limits on releases, and the degree to which effluent limits are met are discussed. (M.C.G.)

12795 ACTION ON REACTOR PROJECTS UNDERGOING REGULATORY REVIEW. J. R. Buchanan. Nucl. Safety, 6: No. 1, 98-107(1964).

Recent regulatory actions are summarized relative to the following reactors: Big Rock Point Nuclear Plant, Bodega Bay Nuclear Plant, BONUS, Connecticut Yankee Reactor, Dresden Reactor, Malibu Nuclear Plant, Nine Mile Point Nuclear Station, nuclear merchant ship N.S. Savannah, Oyster Creek Nuclear Power Station, Pathfinder Reactor, Piqua Nuclear Power Facility, San Onofre Nuclear Generating Station, and Saxton Reactor. Changes in licensing regulations are also discussed. (M.C.G.)

12796 THE METHOD OF NEUTRON CALCULATION FOR THE PRO REACTOR. P. Fornaciari and W. Roncato. Riv. Ing. Nucl., 2: 489-93(July-Aug. 1964). (In Italian)

The method used in neutron calculations for the organic-moderated PRO Reactor is summarized. It is based principally on the codes of the Westinghouse series. The neutron flux and power distributions were evaluated as a function of the insertion of cruciform control rods, and the content of uranium necessary to guarantee a prefixed reactivity for the reactor was determined. (J.S.R.)

12797 DIRECT CONVERSION OF HEAT TO ELECTRIC POWER IN NUCLEAR REACTORS. A. Sellerio and M. C. Spitale. Termotecnica (Milan), 18: 465-78(1964). (In Italian)

Three methods for the direct conversion of nuclear power into electric power, thermoelectric, thermionic, and magnetohydrodynamic methods, are discussed. An indication is given of the present state of development of each of the methods and the study needed to make each feasible. (J.S.R.)

12798 WELDING PROBLEMS ASSOCIATED WITH CONSTRUCTION OF NUCLEAR POWER PLANTS IN JAPAN. Uichi Hashimoto (National Research Inst. of Metals, Tokyo) and Hisashi Kihara. Yosetsu Gakkaishi, 33: 357-63 (Apr. 1964). (In Japanese)

The first nuclear power station in Japan (Advanced Calder Hall type, 166 Mw(e)) is now under construction at Tokaimura. Construction of several new nuclear power stations will begin within a few years and building of the first nuclear powered ship (6500 G.T.) was started in 1963. Al-killed steel plates 80 ~ 94 mm thick were manually welded for the Tokai reactor pressure vessel and its steam raising units were constructed with 54 ~ 74 mm thick boiler plates using both submerged arc and manual welding. JPDR is a small BWR (12.5 Mw(e)), and the inner surface of its pressure vessel was stainless-steel-clad by a submerged arc process. Research on the welding of the nuclear reactor was extensively carried out. Study of the effect of irradiation on the properties of materials has been started. (auth)

12799 A MULTIPURPOSE MILITARY PORTABLE POWER REACTOR. Stephen Luchter (Aerojet-General San Nucleonics, Ramon, Calif.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-2, 8p, $1.00. (CONF-763-40)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Diversity of requirements for the military use of nuclear power to provide electricity prompted the conception of a reactor design that could be used as a heat source by any one of several power-conversion plants, with power-conversion machinery chosen to suit the application. The result of the study is a multi-purpose military portable actor (MMPPR) design, which is described. (auth)

12800 COMPLEX EIGENVALUES IN KINETICS POWER REACTOR DIFFUSION CODES. H. E. Wrigley (Atomic Energy Establishment, Winfrith, Dorset, Eng.). 15p. (CONF-446-72)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The kinetics power reactor diffusion codes are examined theoretically and experimentally for their applicability to cases of both mild and severe disturbances. A scheme is presented that is easy to operate, removes all convergence difficulties, and effects a considerable saving of computer time. Users of the codes are advised not to accelerate the convergence in the early stages of a severe transient. Over each time step, the codes compute and print the largest values of the iteration matrix. This output should be inspected, and application of the acceleration technique should be delayed until the eigenvalue is close to that predicted by the model problem. (H.D.R.)

Production Reactors

12801 (CEA-R-2599) MEASURES DE RAYONNEMENT AUPRES DES PILES G2/G3. (Radiation Measurements Near the G2 and G3 Reactors). Jean-Philippe Chassany and Roger Estournel (France. Commissariat à l'Énergie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). Nov. 1964. 60p. Dep.(mn).

The results are given of radiation measurements: for working sites; for the various zones (circuit room, etc.); during the discharging operations; and for various active materials (CO_2, plugs etc). In general, the protection is suitably designed. The majority of radio-protection prob-

lems are results of elements activated in the pile and transported outside the vessel. (auth)

12802 (HW-83092) TIME-VARIABLE TIME DELAY FOR ANALOG COMPUTER SIMULATIONS. R. A. Walker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 12, 1964. Contract AT(45-1)-1350. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Analog simulation studies of the N-Reactor at Hanford indicate a need for a method of delaying analog signals over varying time periods. A time-variable time delay system was designed and built that accepts analog signals in the range of zero to −10 volts and delays them from 15 to 150 seconds. The control voltage for determining the time delay period must be in the range of zero to +10 volts. (auth)

Propulsion and Space

Refer also to abstracts 11316, 11317, 11388, and 11418.

12803 (AED-C-22-03) NUCLEAR SHIP PROPULSION. Series C: Bibliographies. J. N. Paro, comp. (Reactor Centrum Nederland, The Hague). Dec. 1964. 48p. Dep.(mn).

A total of 114 references with brief notes is presented on all aspects of nuclear ship propulsion. Report, author, and subject indexes are included. (D.L.C.)

12804 (GEAP-3152) PHYSICS METHODS CHECK AND COMPARATIVE POWER CORE ANALYSIS. N. S. SAVANNAH FUEL DEVELOPMENT PROGRAM. H. A. Brammer (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 16, 1959. Contract AT(04-3)-189. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A check is made against experimental data, of physics models used in the Savannah Fuel Program. Comparisons are also made of the estimated nuclear performance of the Babcock and Wilcox first power core with the General Electric second load replacement fuel. Finally, extrapolation from experimental data to the first power core, using General Electric methods, is compared in certain areas to Babcock and Wilcox first core estimates. Calculation of critical loadings of MARTY critical assemblies indicate that, for cores similar to the Savannah power core, General Electric methods are accurate to $\Delta k_{eff} = \pm 0.006$. Factoring in differences in General Electric and Babcock and Wilcox extrapolations to the first power core, the error limits might be as large as $\Delta k_{eff} = +0.006/-0.020$. Comparison of the first and second fuel loads indicate that the General Electric fuel will require about 0.2 percent less fuel enrichment to achieve the same performance as the first core. This results from certain mechanical differences in the second load fuel design which have decreased the steel content of the core. Considering the top limit of error in the calculated k_{eff} of this core, enrichment could possibly be decreased by about another 0.2 percent. If enrichment of the second core fuel is specified on the basis of the mechanical changes only, then reactivity of the core may be adjusted to cover the possible Δk_{eff} errors by the addition of poison to the core (mechanical provision is made for this) to lower reactivity, or switching fuel zones to increase reactivity if necessary. On the other hand, if the upper limit of calculated k_{eff} is considered correct and enrichment specified accordingly, then the possible error in k_{eff} will require the potential of adding reactivity to the core. This could be done by having available an extra half-core of fuel at a slightly higher enrichment. (auth)

12805 (GEAP-3248) PRELIMINARY SUMMARY OF IRRADIATION TESTS CONDUCTED ON N. S. SAVANNAH CORE II TYPE ASSEMBLIES II-2 AND II-3 IN VBWR. N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. R. K. Baird, J. O. Arterburn, F. A. Brandt, and C. N. Spalaris (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 25, 1959. Contract AT(04-3)-189. 43p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Irradiation tests were conducted on N. S. Savannah Core II type assemblies II-2 and II-3 in order to provide experimental data for setting final design parameters for Core II production fuel. Parameters including UO_2 pellet-to-tubing clearances, pellet quality, fabrication processes, and dimensional stability were studied. The two fuel assemblies of nine rods each consisting of half-inch diameter uranium dioxide pellets contained in stainless steel type 304 tubing were operated in the Vallecitos Boiling Water Reactor. They were irradiated for varying periods of time to observe both short and medium term effects when operated under conditions at and above Core II design limiting conditions. Partial data and information are given on the fabrication, irradiation, and post-irradiation examination. Results, conclusions, and recommendation are given, based on the data included. Evidence indicates that Core II fuel is capable of sustained operation without impairing its integrity at heat fluxes and at internal temperatures substantially above design conditions. (auth)

12806 (GEAP-3250) INVESTIGATION OF THE OPERATIONAL CHARACTERISTICS OF THE FUEL ASSEMBLY. N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. R. G. Cochran (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 25, 1959. Contract AT(04-3)-189. 31p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The establishment, by calculational and experimental methods, of the final mechanical configuration of the fuel assembly design is studied. The factors considered in the study are: the shipboard motion and loading criteria; the fuel container deflections resulting from coolant flow pressure gradients; and the mechanical and thermal characteristics inherent to the base, or initial, design concept. (auth)

12807 (GEAP-3252) REFUELING TESTS. PART I. N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. Ramon E. Johnson (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 23, 1959. Contract AT(04-3)-189. 64p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The N. S. Savannah Reactor fuel bundle assembly is tested, with respect to refueling procedures, to assure its compatibility with the reactor refueling system. Trial insertions of the dummy fuel bundle into a simulated core can, while subjecting the bundle to twist, bow, and eccentricity of the core components, produced hang-up of the operation. Each hang-up illustrated a specific defect in the test fuel assembly, and led to a modification of same. At the completion of this test, no hang-ups occurred while subjecting the bundle to excessive bow, twist, and core misalignment. In all cases, the fuel bundle slid in and out of the core with ease. (auth)

12808 (GEAP-3303) REACTOR PHYSICS REPORT. N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. H. A. Brammer (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Dec. 21, 1959. Contract AT(04-3)-189. 53p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The nuclear analysis of the second-core fuel loading designed for the N. S. Savannah is reported. A discussion is given of the methods of nuclear analysis applied to this core. Basic core reactivity data are presented in the form of graphs and tables. Information pertinent to a safeguards analysis of the core is given. Estimates of the fuel lifetime behavior of the core are made. Information on the worth of the reactor control system as a whole and by individual rods is supplied. Local power peaking in a fuel bundle is shown in power maps. The results of a limited study of gross reactor power peaking are also included. (auth)

12809 (GEAP-3367) SAFEGUARDS INFORMATION FOR THE N. S. SAVANNAH REACTOR FUEL MADE BY GENERAL ELECTRIC COMPANY. N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. H. V. Clukey (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 23, 1960. Contract AT (04-3)-189. 136p. Dep.(mn); $4.00(cy), 3(mn) OTS.

The safety of the Nuclear Ship Savannah and its nuclear propulsion plant is analyzed, when the reactor core is loaded with the fuel elements designed and manufactured by the General Electric Company. The principal mechanical, thermal, hydraulic, and nuclear features of this second core are described. (auth)

12810 (GEAP-3375(Rev.1)) N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. ANALYSIS OF PARTICULAR MECHANICAL CHARACTERISTICS OF THE CORE II FUEL ASSEMBLY. R. G. Cochran (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 9, 1961. Contract AT(04-3)-189. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

As a result of the analysis, it was found that: The center spacer maximum operational deflection is 0.024 inch, while the deflection at failure is 0.350 inch. The impact load from a maximum roll of 30° is 4.77×10^4 ft-lb. The minimum fuel-rod clearance with the ship on its side and 2g loading applied, is 0.139 and 0.096 inch, respectively. The load on the center spacer lobe with 30° roll is 131 lb and with the ship on its side 188 lb. The lobe placement is optimum at the corner fuel rod. (D.L.C.)

12811 (GEAP-3559) IRRADIATION RESULTS, N. S. SAVANNAH CORE II PROTOTYPE FUEL ASSEMBLIES. (ASSEMBLIES SAV-II-2 AND SAV-II-3). F. A. Brandt, J. O. Arterburn, R. K. Baird, C. N. Spalaris, and M. K. Wolverton (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Nov. 7, 1960. Contract AT(04-3)-189. 98p. Dep.(mn); $3.00(cy); 2(mn) OTS.

Two N. S. Savannah, second-core prototype fuel elements were designed, fabricated, irradiated, and destructively examined. One stainless-steel-clad UO_2-pellet fuel element was irradiated to 1800 Mwd/T at moderate heat fluxes followed by irradiation for 80 Mwd/T at 350,000 Btu/hr ft^2. The other was irradiated to 100 Mwd/T at 400,000 Btu/hr ft^2. Post-irradiation dimensional measurements, gamma survey, fission gas release, fuel macro- and microstructure burnup, and cladding mechanical-property data were determined for both elements. (auth)

12812 (NAA-SR-Memo-10499) ELECTROMAGNETIC INTERFERENCE TEST OF THE ANALOG POSITION SENSOR DEMODULATOR TYPE NE10FSM1-24-010, TYPE M 17414, SERIAL NUMBER 25. W. Holsborg (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 29, 1964. Contract AT-11-1-GEN-8. 17p.

Conducted and radiated electromagnetic interference tests performed on a demodulator assembly for SNAP-10A. The results of the tests described herein indicate that the test specimen does not exceed the limits specified for the generation of conducted and radiated broadband interference. The test specimen was, however, susceptible to audio-frequency interference induced on the 28-v d-c power leads throughout the frequency range of 50 to 130 cps. (auth)

12813 (NASA-TN-D-2594) IMPROVED METHOD OF PREDICTING SURFACE TEMPERATURES IN HYDROGEN-COOLED NUCLEAR ROCKET REACTOR AT HIGH SURFACE- TO BULK-TEMPERATURE RATIOS. John V. Miller and Maynard F. Taylor (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Jan. 1965. 22p. $1.00(OTS).

Local heat-transfer coefficients of gaseous hydrogen obtained in several experiments are compared to the coefficients predicted by various empirical correlations. Of particular interest in nuclear rocket reactor design is a problem encountered at high surface- to bulk-temperature ratios, where a decrease in gas temperature causes an increase, rather than a decrease, in the predicted surface temperature. The conclusion is reached that a correlation exists. (auth)

12814 BEYOND APOLLO WITH NUCLEAR PROPULSION. Paul G. Johnson (AEC-NASA Space Nuclear Propulsion Office, Germantown, Md.). Astronaut. Aeronaut., 2: 22-8(Dec. 1964).

A summary of solid-core nuclear rocket applications is presented for missions beyond the initial Apollo lunar exploration. The primary uses of nuclear rockets are shown to be in manned missions to the near planets, and the planning factors are examined for early Mars missions propulsion requirements. Advantages are also seen in the use of nuclear rockets in several phases of post-Apollo lunar missions and in high-payload unmanned interplanetary missions. (H.D.R.)

12815 SIGNIFICANCE OF ATOMIC ENERGY FOR THE GERMAN SPACE PROGRAM. G. F. Au (Institut für Strahlantriebe, Brunswick). Atomwirtschaft, 8: 488-96(Sept. 1963). (In German)

A survey on atomic energy for space travel indicated three broad purposes for this power source. These are atomic energy installations for exit and reentry orbits to and from planets, electric and nuclear-electric power systems for satellite orbits and interplanetary missions, and auxiliary power sources for provision of electrical energy to ship instrumentation. Nuclear engines have advantages of higher streaming velocity, single propellant and greater usability factor compared to a chemical installation. However, they are radioactive, require shielding, and have a low thrust/mass ratio. The principle of atomic power motors is that thermal energy is produced to produce streaming of a gas through a jet. Liquid H produces the greatest streaming velocity. Relatively high reactor power is indispensable, because the thrust obtained is proportional to the reactor capacity. Nuclear energy sources for electrical plants include thermionic generators and magnetogasdynamic generators. Electrical plants include electrothermal plants, where a gas is ionized in an electrical field and the plasma formed is accelerated in an electrostatic field, and electromagnetic plants. These may be continuous or discontinuous. Electrothermal plants do not have important advantages over thermal procedures. The electrostatic ion devices and the electromagnetic devices have significant favorable characteristics. (BBB)

12816 FISSION-FRAGMENT-CAUSED SHEAR STRESS IN GASEOUS VORTEX REACTORS. D. B. Harmon and E. M. Svaton (Douglas Aircraft Co., Inc., Santa Monica, Calif.). J. Spacecraft Rockets, 1: 444-5(July-Aug. 1964).

As an adjunct to work on fission fragment energy losses, a computer-program subroutine was included which calculated, for several different cylindrical gas cores, the momentum carried across any boundary in the core for a preset U content and various gas number density ratios compared to atmospheric. Results of these calculations are presented, along with a brief discussion of the restrictions on the calculations. It is shown that fission fragments could cause significant shear stresses in gaseous core nuclear vortex reactors. It is concluded that uncoupling of the nuclear and hydrodynamic equations in the vortex type of fission reactors is usually impossible. (M.J.T.)

12817 THERMAL AND FAST REACTOR SYSTEMS AS ENERGY SOURCES FOR ELECTRIC SPACE FLIGHT PROPULSION. R. Pruschek and H. E. Unger (Technische Hochschule, Stuttgart). Raumfahrtforschung, 8: 145-9 (Oct.-Dec. 1964). (In German)

The most important energy sources for ion propulsion are nuclear reactor systems, the heat generated therein being transformed directly into electric energy by means of thermionic converters. The use of thermionic converters may be preferable to turbogenerators, since no rotating parts are necessary in the conversion system; in addition, higher temperatures can be achieved. Both, fast and thermal reactors, might be useful for generators of energy in space. The most important points of view for design and choice of proper reactor elements and materials for space conditions are demonstrated. Furthermore, methods of nuclear and thermodynamic calculations of those reactors as well as their use for design, optimization, and construction of nuclear space are discussed. Two of the most important characteristic values of those plants are their

specific power (power-to-weight-ratio) and their electric power output. Calculated values of specific power for several types of reactors in function of total power are shown and discussed. (auth)

12818 PROGETTI ED ESPERIENZE NEL SETTORE DELLA PROPULSIONE NAVALE NUCLEARE, TORINO, 2-3 OTTOBRE 1962. (Projects and Experiments in the Area of Naval Nuclear Propulsion, Turin, October 2-3, 1962). Rome, Cimitato Nazionale Energia Nucleare, 1964. 595p. (CONF-148)

Separate abstracts were prepared for twenty of the twenty-two papers included on nuclear propulsion. One other paper was previously abstracted in NSA (17: 38560). (D.C.W.)

For abstracts of individual papers see: 11316, 11317, 11318, 12819, 12820, 12821, 12822, 12823, 12824, 12825, 12826, 12827, 12828, 12829, 12830, 12831, 12832, 12833, 12834, and 12835.

12819 NUCLEAR STEAM RAISING PLANT SUITABLE FOR 7,000 SHAFT H. P. VESSEL. T. Deighton (Babcock and Wilcox, London). p.161-72 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The design and characteristics of the saturated water reactor proposed for the oceanographic vessel are presented. The safety control and operation response, heat removal, waste disposal, electric supply, and conventional machinery are described. (J.S.R.)

12820 CONSOLIDATED NUCLEAR STEAM GENERATOR FOR MARINE PROPULSION. R. T. Schomer and D. C. Purdy (Babcock and Wilcox Co., [Alliance, Ohio]). p.223-53 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The design of a consolidated nuclear steam generator (CNSG) that was the result of the knowledge and experience gained from the design, fabrication, and operation of the NS Savannah combined with up-to-date technology and advanced design studies was presented. All of the primary system including the reactor core and steam generator are consolidated within one pressure vessel. The design is presented in detail, and the results of an economic analysis are also given. (J.S.R.)

12821 NATURAL CIRCULATION REACTORS FOR MARINE PROPULSION. J. H. MacMillan, D. M. Graham, and G. E. Kulynyck (Babcock and Wilcox Co., [Lynchburg, Va.]). p.255-78 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The design and characteristics of the Integral Boiler Reactor (IBR), a simplification of the closed-cycle pressurized water reactor fueled with oxide rod elements in which the secondary steam generating surface is incorporated within the reactor vessel, are described. Variations on this basic design are also considered. (J.S.R.)

12822 NATURAL CIRCULATION PRESSURIZED WATER REACTOR. L. Chinaglia (FIAT, Turin). p.279-89 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In Italian)

The preliminary design and characteristics of a 87.5-Mw natural circulation pressurized water reactor under study and development to determine the feasibility of this reactor type for marine propulsion are described. The advantages that led to its selection for study are discussed. (J.S.R.)

12823 MARITIME REACTORS WITH HIGH-TEMPERATURE GAS COOLING. W. I. Thompson and R. T. Shanstrom (General Atomic Div. General Dynamics Corp., San Diego, Calif.). p.291-303 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

Design information is presented on two maritime reactor designs. One is helium cooled and moderated with beryllium oxide. The other is moderated with zirconium hydride and cooled with carbon dioxide. (J.S.R.)

12824 INHERENT LIFETIME REACTIVITY CONTROL THROUGH CHANGES IN MODERATOR DENSITY. P. C. Zmola, R. J. Rickert, and W. S. Flinn (Combustion Engineering, Inc., Windsor, Conn.). p.305-12 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The extent to which all reactivity variations over the operating life of the core can be controlled through self-regulated changes in coolant densities was studied. The plant concept of an indirect-cycle water reactor that would permit operation at sea for several months or the core lifetime without control rod motion for all operating conditions is indicated. The reactivity control is considered in some detail. (J.S.R.)

12825 THE WASTE DISPOSAL SYSTEM FOR THE MH-1A NUCLEAR POWER PLANT FOR THE SS WALTER F. PERRY. T. S. Weissman (Martin-Marietta Corp. Aerospace Div., Baltimore). p.313-29 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The processing and disposal of liquid and gaseous wastes from the 10,000-kwe pressurized-water power plant designed for the SS Walter F. Perry are described. The liquid wastes are handled either by dilution with the sea water condenser flow or holdup followed by evaporation and dilution. Gaseous wastes are diluted with the ventilation air for the containment vessel. Silver nitrate is used to remove the iodine from the gases collected. Solid wastes are stored in shielded shipping containers. (J.S.R.)

12826 EXTENSION OF REACTOR SITE SELECTION GUIDES TO OPERATION OF NUCLEAR SHIPS. C. K. Beck (Atomic Energy Commission, Washington, D. C.). p.331-8 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The primary principles underlying the guides to site selection of land-based reactors are reviewed. The factors involved in their extension to the operation of nuclear ships are explored. (J.S.R.)

12827 CONSIDERATIONS REGARDING THE OPERATION OF NUCLEAR VESSELS IN PORT AREAS. W. B. Cottrell (Oak Ridge National Lab., Tenn.). p.339-57 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

Some of the more pertinent analyses performed to evaluate the consequences of activity releases from the NS Savannah maximum credible accident, to review the tentative criteria for the port operation of nuclear ships, and to indicate how the calculated exposures compare to the criteria are presented. (J.S.R.)

12828 SOME COMMENTS ON THE AMERICAN BUREAU OF SHIPPING "GUIDE FOR THE CLASSIFICATION OF NUCLEAR SHIPS." J. W. Heck (American Bureau of Shipping, New York). p.359-69 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The recently published "Guide" gave more precise data in some design areas than had been previously available. The forces due to ship motions, collision damage consideration, and shielding considerations, as reviewed in the "Guide", are discussed. Areas in which experience with NS Savannah indicates the need for special consideration are emphasized. (J.S.R.)

12829 CONSIDERATIONS ON SAFETY CONTAINERS FOR NUCLEAR SHIPS. G. Bourceau and R. Mattera (Bureau Veritas, Paris). p.371-90 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In French)

The necessity for a reactor containment vessel is shown. The degree of certainty with which a determination can be made of the internal and external pressures that the vessel must withstand in case of an accident is discussed. It is shown how a selection can be made of the steel, the maximum permissible stress, and the test pressure so that the containment vessel will fulfill its function without making futile the weight estimation of the ship. (J.S.R.)

12830 THE PRESENT STATUS OF SHIP PROPULSION BY NUCLEAR ENERGY AS VIEWED BY A NAVAL CIVIL ENGINEER. F. Spinelli (Universita, Naples). p.391-454 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In Italian)

The basic constituents of reactors are briefly reviewed. The coolant system used in different reactor types is indicated, and the characteristics of nuclear reactors currently in use for ship propulsion are summarized. The economic aspects of nuclear merchant ship are discussed. (J.S.R.)

12831 SPECIAL PROBLEMS FOR SHIP PROPULSION BY NUCLEAR POWER. H. Schmerenbeck (Gesellschaft fur Kernenergieverwetung in Schiffbau und Schiffahrt mbh, Hamburg). p.455-67 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964.

The experiences to be gained in the design, construction, and operation of nuclear powered ships are considered with respect to the types of ship proposed. The special requirements for the hull and propulsion unit (reactor and machinery) are discussed. The factors causing the present uneconomic state of nuclear ships are reviewed. (J.S.R.)

12832 PROJECT PARTICULARS OF A TURBOELECTRIC PROPULSION NUCLEAR TANKER WITH A DIRECT-CYCLE BOILING REACTOR. G. Reggio (Ansaldo S.P.A., Genoa). p.469-86 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In Italian)

The design characteristics of a nuclear tanker with a direct-cycle BWR are summarized with particular emphasis on the weight distribution. The energy cycle and thermal balance are evaluated. (J.S.R.)

12833 STOPPING DISTANCE OF SHIPS IN CONNECTION WITH COLLISION HAZARDS WITH PARTICULAR REGARD TO NUCLEAR PROPULSION. R. Breglia (Universita, Naples). p.487-96 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In Italian)

The primary emphasis in analysis of collision hazards in nuclear ships has been on passive protection—maintaining reactor security in the event of collision. An active protection—means for reducing the possibility of collision—is analyzed for ships of various tonnages. (J.S.R.)

12834 NUCLEAR COMMERCIAL SUBMARINES. G. Zamparo (Ansaldo S.P.A., Genoa). p.497-536 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In Italian)

The performance of surface and underwater vessels as tankers or ore carriers are compared. The characteristics of submarines that must be considered in their evaluation as commercial vessels (hull types, cargo distribution, and ventilation) are discussed. Design of nuclear commercial submarines now under study are reported, and cost evaluations are given. (J.S.R.)

12835 THE FEASIBILITY OF BOILING WATER REACTORS IN THE SHIP INDUSTRY. L. K. Werner (AEG, Frankfurt). p.537-49 of "Progetti ed Esperienze nel Settore della Propulsione Navale Nucleare." Rome, CNEN, 1964. (In German)

Studies made by the AEG for a ship installation of 20/20,000 WPS using a boiling water reactor with direct cycle are summarized. The studies can be divided into those that are necessary for the function and operation of the reactor itself, those that are necessary for the operational security of the installation or for safety, and those that have economic significance. The studies concerned stability problems, burnout, water–steam separation, control rod function, corrosion of Zr-2 by sea water, materials testing, and shielding. (J.S.R.)

12836 DESIGN AND FABRICATION OF SNAP REACTOR VESSELS. Thomas L. Anderson and Igor A. Awtamonow (Atomics International, Canoga Park, Calif.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/NE-7, 8p, $1.00. (CONF-763-21)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The design and fabrication of reactor vessels for SNAP-8 and SNAP-10A are described. The selection of a material for the reactor vessel considered not only the primary design criteria but also a number of other conditions. Type 316 austenitic stainless steel was selected because it was found to have good resistance to liquid metal corrosion while at the same time providing economy, reliability, and ease of fabrication. Type 316 stainless steel was also selected for the grid plates to provide thermal expansion identical to the reactor vessel. (P.C.H.)

Research and Test Reactors

Refer also to abstracts 11375 and 11696.

12837 (HW-84082) PLUTONIUM RECYCLE TEST REACTOR PLUTONIUM CALCULATIONS. J. W. Handshuh (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 14, 1964. Contract AT(45-1)-1350. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The 7090 FORTRAN program written to calculate the plutonium net production and uranium burnout in PRTR fuels. The input data are the accumulated, elemental Mwd's from PRTR. The program uses empirical polynomial functions developed by correlation between heat and isotopic concentrations taken from MELEAGER calculations. Plutonium and uranium isotopes are reported for each element as well as the totals. (auth)

12838 (IDO-10044) PROPOSED LOFT MELTDOWN ANALYSIS: TASK II. R. J. Walker (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Sept. 1964. Contract AT(10-1)-1195. 63p. (BAW-1195-1). Dep.(mn); $3.00(cy), 2(mn) OTS.

The general equation for heat balance can be applied to any node within the model of the reactor and containment atmosphere. This general equation includes the effects of heat generation, radial and axial conduction, radial and axial convection, radial and axial radiation, heat storage for increasing or decreasing the node temperature, and heat storage for receiving or relinquishing the node latent heat. In this way the general equation accounts for the node temperature as a function of time. Other equations will account for the mass transfer as each node melts. The initial temperature is that of the steady state condition at normal operating power. The first purpose for writing the general equation for each region within the model is to incorporate changes in subscript notation necessary for machine programming. Such variation in subscript notation is required to identify heat flow paths in both fueled and nonfueled regions. Another purpose for writing the general equation for particular regions is to allow for the elimination of some nodes as the steam coolant is replaced by air or as melting causes relocation of the reactor material to a lower node. The steam receives heat by radiation from the cladding. When the steam is replaced by air, the general equation must be rewritten to account for the changed heat transfer by radiation from the cladding to other cladding. Any chemical reaction that may be induced because of the elevated temperatures experienced in this analysis will not be accounted for. For example, the fuel and cladding will probably oxidize (depending on the core atmosphere) as melting temperatures are approached, but it will be assumed that each node remains as one material throughout the analysis. (auth)

12839 (IDO-10045) EVALUATION OF CORE MELTDOWN FOLLOWING LOFT AND PM-2A LOSS-OF-COOLANT ACCIDENTS. L. J. Stanek, R. J. Walker, and W. R. Pierce (Babcock and Wilcox Co. Atomic Energy Div., Lynchburgh, Va.). Oct. 1964. Contract AT(10-1)-1195. 33p. (BAW-1195-2) Dep.(mn); $2.00(cy), 1(mn) OTS.

The time to reach initial melting of cladding and the percentages of fuel and cladding at melting temperature versus time following a loss-of-coolant accident were determined using a digital computer program based on a thermal model of the reactor core. The analysis was performed on the LOFT (50 Mwt). LOFT High Power Density (80 Mwt), and PM-2A (12 Mwt) cores to determine the effects of power density and equivalent core diameter on the melting conditions. Elapsed time from scram for 1% of the cladding to reach melting temperature (2550°F) was less than 0.005 hour for all three cores. Fifty percent of the cladding reached melting temperature in 0.14, 0.01, and 0.065 hour for LOFT (50 Mwt), LOFT (80 Mwt), and PM-2A (12 Mwt) cores, respectively. Forty percent of the fuel reached fuel melting temperature (5000°F) in 4 hours for the LOFT (50 Mwt) core and in 0.765 hour for the LOFT (80 Mwt) core. Approximately 2 and ½% of the PM-2A core had reached 5000°F in 0.85 hour, when core temperatures began decreasing. (auth)

12840 (IDO-10046) LOSS-OF-FLUID TEST FACILITY (LOFT) BLOWDOWN ANALYSIS. Parametric Study of System Pressure Transients. Charles E. Parks (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Nov. 1964. Contract AT(10-1)-1195. 75p. (BAW-1195-3). Dep.(mn); $3.00(cy), 2(mn) OTS.

This study determined the transient response of the system pressure and flow rates in the LOFT experimental facility after the occurrence of a rupture in the primary piping. Operating pressure, operating temperature, leak size, leak location, and core resistance were varied. The LOFT primary system was simulated on a general-purpose analog computer. A rupture in the system was simulated, and by using continuous mass, energy, and force balances the system pressures and flows were calculated and recorded as functions of time. For a rupture of cross-sectional area equivalent to that of the primary piping (16-inch ID) the results indicated that the core will be uncovered for all leak locations and that the system will be emptied (95% mass removal) in 9 or 10 seconds. The results also indicated that the core will be subjected to large pressure loadings immediately after rupture. Smaller leaks as well as a decrease in subcooling of the primary fluid will produce smaller pressure differentials across the core. (auth)

12841 (IDO-17030) SPERT PROJECT QUARTERLY TECHNICAL REPORT, APRIL–JUNE 1964. A. H. Spano, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 1964. Contract AT(10-1)-205. 65p. Dep.; $3.00(cy), 2(mn) OTS.

The Spert I program of potentially destructive short-period power excursions in a low-enrichment UO_2 core was concluded with the performance of a test initiated by a combined control-rod-ramp and transient-rod-step insertion of reactivity totaling 3.3$. In this test, the relatively minor destructive effects obtained were similar in nature and extent to those obtained in an earlier 2.2-msec-period test, with core damage limited to the rupture of two fuel pins and the permanent bowing of about one-fourth of the fuel pins in the core. A preliminary analysis of the ruptured pins indicates that steam explosions within the fuel pins were the probable cause of the cladding ruptures. Preparations were begun to install another water-moderated, low-enrichment UO_2 core in Spert I. The new core, designated the Capsule Driver Core (CDC), will be used for fuel element meltdown tests, reactivity shutdown mechanism studies, fisside release studies, and other capsule-type investigations. Static measurements of the nuclear parameters of the CDC core will be made in Spert I prior to installation of the core in Spert IV. The Spert II, close-packed, D_2O-moderated-core transient testing program was completed with a series of tests investigating the effects of forced coolant flow and system temperature on the dynamic behavior of the Spert II core. In addition, transient tests were performed to determine the power level threshold required to attain a departure-from-nucleate-boiling condition and fuel plate burnout in the close-packed core for given system conditions. The series of tests to investigate the self-limiting transient behavior of the Spert III plate-type as a function of initial system temperature was completed with the performance of 51 step-initiated transient tests and two ramp-initiated transient tests, conducted with system temperatures up to a maximum of about 610°F. Preparations were also made for a final test series in the Spert III plate-type core program. This final series will include transient tests initiated from high power density levels and tests simulating various types of operational accidents. The PBF fuel testing program was continued with in-pile transient irradiation tests of prototype fuel pins. A series of PBF mock-up critical assembly tests was carried out in the Spert IV facility to obtain basic, clean-core criticality data on highly packed lattices of low enrichment fuel pins with nonmoderator-to-moderator ratios of 1.9 and 2.3. The data obtained provide experimental checks of the physics calculational methods used in the PBF reactor design. Preliminary studies were also completed to determine the feasibility of PBF operation at steady state power levels of several Mw. Such an operation would permit an increased experimental flexibility for the PBF beyond its principal application as a pulsed test reactor. (auth)

12842 (NP-14591) SAFETY CONSIDERATIONS IN PULSED NEUTRON EXPERIMENTS (thesis). Matthew Whitehill Tobriner (California. Univ., Berkeley). [1964]. 70p. (DOCKET-50-84). Dep.(mn); $3.00(cy), 2(mn) OTS.

Safety hazards are studied in the operation of the TNC Neutron Generator when placed in the core of the AGN-201 nuclear reactor. The response of the reactor–neutron generator system is measured using the neutron generator in the licensed pulsed mode. The results are compared with solutions of the kinetic equations for various values of the reactivity. The kinetic equations are solved using the thermal diffusion model and assuming one "effective" group of delayed neutrons. Predictions are made concerning the response of the system to the maximum steady neutron source strength. The maximum possible accident is investigated. It is concluded that it is safe to operate the neutron generator with its maximum steady source strength in the reactor for any available value of the reactivity. (auth)

12843 (ORNL-3756) NEUTRON FLUX SPECTRA IN THE EXPERIMENTAL FACILITIES OF THE OAK RIDGE RESEARCH REACTOR. C. D. Baumann (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 26p. Dep.; $2.00(OTS).

The neutron flux spectra for the various experimental facilities of the Oak Ridge Research Reactor are presented in tabular and graphical form. Both the energy and the spatial variation are included. (auth)

12844 (ORNL-TM-1023) TUBE PLUGGING IN THE MOLTEN-SALT REACTOR EXPERIMENT PRIMARY HEAT EXCHANGER. R. G. Donnelly (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In order to reduce the pressure drop through the shell side of the Molten-Salt Reactor Experiment primary heat exchanger, it was decided to remove four of the outer U-tubes. This required sealing the eight tube stubs produced. A plug design and seal welding procedure were developed to assure a high-integrity seal between the molten fuel salt on the shell side and the coolant salt on the tube side of the heat exchanger. The plugs were made to have a slight interference fit (0.0000 to 0.0002 in.) with the tubes and were machined for edge-welding. The plug material was INOR-8 as was the entire heat exchanger. The procedure for making the seals was to manually weld the tube end to the plug with a gas tungsten-arc torch. The welding conditions were adjusted to provide weld metal penetration equivalent to at least the thickness of the tube wall. Visual, dye-penetrant, and radiographic examinations of the welds gave every indication that high-integrity welds had been made that would successfully isolate the fuel salt from the coolant salt during the planned operation of the heat exchanger. (auth)

12845 (SC-RR-64-1757) RADIATION FLUX MAP REPORT—SANDIA ENGINEERING REACTOR FACILITY. C. B. Becherer (Sandia Lab., Albuquerque, N. Mex.). Jan. 1965. Contract [AT(29-1)-789]. 39p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

This report presents the results of the radiation flux mapping program at the Sandia Engineering Reactor (SER). The neutron fluxes above various energies and the gamma dose rates were measured in the SER core, in the irradiation cell, and in various experimental locations. (auth)

12846 MICROWAVE MEASUREMENT OF DYNAMIC REACTOR RESPONSE. Ashok Bhattacharya, L. Goldstein, F. T. Adler, J. T. Verdeyen, and E. P. Bialecke (Univ. of Illinois, Urbana). Appl. Phys. Letters, 5: 242-4(Dec. 15, 1964).

One of the outermost fuel elements in the Mark II Triga Reactor was replaced by a circular waveguide connected to an external microwave circuit. When the gas in the core section was ionized, changes in the electromagnetic wave signal provided a direct measurement of the electron density in the core. Comparison of microwave and independent measurements indicate the microwave technique provides an excellent tool to measure and monitor the reactor response instantaneously over four orders of magnitude in power without recourse to conventional in-core instrumentation. (H.D.R.)

12847 THE HEALTH PHYSICS RESEARCH REACTOR. J. A. Auxier (Oak Ridge National Lab., Tenn.). Health Phys., 11: 89-93(Feb. 1965).

The Health Physics Research Reactor became operational at the Oak Ridge National Laboratory on May 31, 1963. A small, unshielded, and uncooled fast reactor, the HPRR was designed as a versatile tool for research in health physics and related fields. The core is a right, circular cylinder (8 in. in diameter and 9 in. high) of enriched uranium (93.14 per cent ^{235}U) alloyed with 10 per cent by weight of molybdenum. Steady-state power levels range from 0.1 w or less to 10 kw, and the pulse mode yields pulses in the range of 10^{16}-10^{17} fissions per pulse. For a pulse of 10^{17} fissions, the pulse width at half-maximum pulse height is about 60 μsec. The fast neutron to gamma ray dose ratio at distances up to several m is approximately 10. Dose rate for a fixed geometry may be varied by 12 orders of magnitude; the fast neutron dose rate at 1 m from the center of the core is approximately 3.3 tissue rad per hr/W. The facility has, in a number of cases, been made available for worthwhile research projects originating in other laboratories. (auth)

12848 TREATMENT OF THE WATER OF THE RESEARCH REACTOR OF THE TSING-HUA UNIVERSITY. G. C. Lin (National Tsing-Hua Univ., China). Ho Tsu K'o Hsueh, 4: 123-34(Feb. 1964). (In Chinese)

Water treatment at the Tsing-Hua Open-pool Reactor over 2.5 yr of operation is reviewed. The primary coolant of the reactor was analyzed. Radiation effects on the primary coolant are discussed, and a preliminary analysis of radioisotopes produced in the primary coolant during operation at 1 Mw is also reported. (D.C.W.)

12849 FLUX MEASUREMENTS OF THE NEW BEAM HOLE FOR THE MTR VELOCITY SELECTOR. R. M. Brugger (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Instr. Methods, 32: 303-8(Feb. 1965).

Measurements of the flux of neutrons from the HT-1 through hole of the MTR show that a square source block 2″ thick is more effective than a ⅜″ thick plate placed at a reflecting angle to the beam. With the 2″ thick polyethylene block, a beam of thermal neutrons of 8×10^9 n/cm²sec are available at the cubicle face while the cadmium ratio for an indium detector is 4.47. These measurements indicate that when the velocity selector is moved from its present hole to HT-1 north, the following gains can be realized; thermal flux × 14, thermal signal to fast background × 28, resonance region signal to fast background × 56. (auth)

12850 THE ANALOG SIMULATOR OF THE NUCLEAR REACTOR RTS-1. Giovan Gualberto Lisini (Universita, Pisa, Italy). Riv. Ing. Nucl., 2: 479-88(July-Aug. 1964). (In Italian)

The analog simulator of the 5-Mw RTS-1 swimming-pool reactor is described, together with its operation. (D.C.W.)

12851 RAPID DETERMINATION OF THE TEMPERATURE COEFFICIENT IN CERTAIN TYPES OF NUCLEAR REACTORS. Elio Oliveri. Termotecnica, (Milan), 18: 479-84(1964). (In Italian)

The temperature coefficient of reactivity is a very important parameter in the technology of nuclear reactors. In some cases, as is shown, it can be measured very rapidly by using power transistors. A test on the AGN-201 "Costanza" Reactor showed that the value of the measured temperature coefficient approximates very closely the value indicated by the constructor. (tr-auth)

12852 NUCLEAR REACTORS AS SOURCES OF RADIATION. C. D. Bopp and W. W. Parkinson, Jr. (Oak Ridge National Lab., Tenn.). p.1-34 of "Radiation Sources." New York, The Macmillan Company, 1964.

The characteristics of reactors that are important for radiation effects studies are discussed. The radiation from fission and its modification in the reactor core are described. The interactions of neutrons with materials are considered, with special emphasis on the production of displacements by fast neutron collisions. Dosimetry of radiation is described. Reactors are compared with other sources of radiation, and characteristics of research reactors important for materials irradiation studies are discussed. (M.C.G.)

12853 IRRADIATION FACILITIES AND EXPERIMENTAL TECHNIQUES IN NUCLEAR REACTORS. T. H. Blewitt (Argonne National Lab., Ill.). p.660-81 of "The Interaction of Radiation with Solids." New York, Interscience Publishers, 1964.

Uses of reactors for radiation damage studies on solids are discussed. Neutron flux measurements for reactors are described. Design of irradiation facilities is considered, and the Argonne irradiation facilities are described. Cooling techniques, liquid helium facilities, annealing experiments, temperature measurements, and stored energy measurements are discussed. (M.C.G.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 11264 and 12825.

12854 (UJV-1110/64) USTANOVKI PO OBESVREZHIVANIYU PADIOAKTIVNYKH OTKHODOV. (Radioactive Waste Decontamination Installations). V. Vesely, A. Enichek, and I. Yansa (Československá Akademie Věd. Ustav Jaderného Výzkumu, Řež). 1964. 14p. Dep.(mn).

A boiler type evaporator and a small film evaporator used for decontamination of radioactive liquid waste are described. (R.V.J.)

12855 TREATMENT OF LIQUID WASTE CONTAINING CHROMIUM-51. E. J. Huang and T. S. Yang (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 135-7 (Feb. 1964). (In Chinese)

A simple precipitation method for treating liquid wastes containing ^{51}Cr is described. The pH of the waste solution is adjusted to 8 with 1-N HCl, after which the Cr is precipitated by adding a $Pb(NO_3)_2$ solution. After treatment, the filtrate activity is near the background activity. (D.C.W.)

12856 EXCHANGE-ADSORPTION OF RADIOACTIVE CATIONS BY ZEOLITIC TUFF. Hiroshi Takahashi and Mutsumi Nishidoi. J. Clay Res. Group Japan, 3: 239-45 (Nov. 1963). (In Japanese)

The exchange-adsorption of radioactive ^{90}Sr and ^{137}Cs in batch system by zeolitic tuff from Kawarago, Shiroishi, Miyagi Prefecture was studied. The relation between the affinity of both radioactive cations and the form of exchangeable cation of adsorbent was investigated in NaCl chloride solution. In general, the mono-valent forms show the selectivity for ^{90}Sr except H-form, while the divalent forms do not show so remarkable selectivity. H-form only shows the highest selectivity for ^{137}Cs. Moreover, zeolitic tuff show the higher capacity for these both cations than other clay minerals, for example, kaolinite or montmorillonite. Since the zeolitic tuff is relatively soft mineral and swells very little in water, it is very effective and economical to apply it for the treatment of radioactive aqueous waste. (auth)

12857 NUCLEAR WASTE MANAGEMENT IN CANADA. C. A. Mawson (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Water Pollution Control Federation, 35: 1055-65 (Aug. 1963).

A review of waste management is presented, including disposal to sail and disposal in a sewer system. Disposal methods at Chalk River are emphasized. It is noted that the majority of Chalk River waste goes to the Ottawa River or decays on its way. The rise in radioactivity in this River associated with plant operation is much less than the natural radioactivity present. (J.R.D.)

12858 DISPOSAL OF RADIOACTIVE WASTES IN FRESH WATER. F. L. Parker. Nucl. Safety, 6: No. 1, 89-97(1964).

The discharge of radioactive waste into fresh-water systems is discussed. The Clinch River studies, IAEA recommendations, studies of river sediment, system analyses of river pollution, and foreign studies of waste balances are discussed. (M.C.G.)

12859 WASTE DISPOSAL. Reactor Fuel Process., 7: No. 2, 131-45(1964).

Research progress or liquid-waste treatment by ion exchange and foam separation, conversion of high-level-activity wastes to solids, final disposal methods, recovery of fission products, and corrosion in waste processing is reviewed. (23 references). (M.C.G.)

12860 WHAT HAPPENS TO RADIOACTIVE WASTE IN SWITZERLAND AND OTHER COUNTRIES? K. Eschle. Schweiz. Tech. Z., 60: 969-73; 989-95(Nov. 1963). (In German)

After a description of the origin of the main types of radioactive waste (preparation of nuclear fuels in reactors, reprocessing of used fuel slugs, use of radioisotopes in laboratories, hospitals and industry), modern methods of handling and storing radioactive waste are reviewed. Solid, liquid, and gaseous wastes are dealt with separately, and each of these groups is broken down into at least three subgroups according to activity (low, medium or high). Finally radioactive waste in Switzerland is given special attention. (Occupational Health Safety Abstr., 2: (1964))

12861 WASTE INCINERATOR FOR BURNABLE PLUTONIUM WASTE (Engineering Materials). (Dow Chemical Co. Rocky Flats Plant, Devner). (CAPE-1182)

The incinerator is used as a production unit to efficiently recover plutonium values from wastes and to reduce the volume of necessary storage. The facility includes the incinerator, 3 heat exchangers, slag wool filters, tar sump, and a walk in plenum. The plenum facilitates changing filters and monitoring filter conditions. Also included are drawings describing a glove box, piping, and a fire detection system. Thirty-eight drawings are included. (P.C.H.)

GENERAL AND MISCELLANEOUS

12862 (CU-2663-14) CARIBBEAN CURRENT MEASUREMENTS, JULY 1964. Robert Gerard (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Dec. 1964. Contract AT(30-1)-2663. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Current measurement observations and other oceanographic work were carried out on the Research Vessel CONRAD in the Caribbean Island arc area. A cruise narrative is given. The performance of the instruments used (parachute drogue, in situ temperature/salinity/depth recorder, photographic meter, etc.) is discussed. Sound velocity profiles and deep-pumping experiments are also discussed. (D.L.C.)

12863 (DP-929) PUBLICATIONS, 1951 THROUGH 1963. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1964. Contract AT(07-2)-1. 124p. Dep.; $4.00(OTS).

A compilation is presented of the reports, journal articles, contributions to books, computer programs, and other items published by DuPont in its atomic energy activities between 1951 and 1963. The compilation is in the form of bibliographic, subject (keyword in title), and author listings. (D.L.C.)

12864 (HW-68600-46) PLUTONIUM ABSTRACTS. Volume 4, Number 12. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 2, 1965. Contract AT(45-1)-1350. 22p. Dep.; $2.00(OTS).

A total of 35 abstracts are presented on new developments on plutonium technology. The abstracts are arranged under the following headings: biology and medicine, chemistry, metallurgy and ceramics, physics, and reactor technology. (D.L.C.)

12865 (NAA-SR-10501) AEC UNCLASSIFIED PROGRAMS. Quarterly Technical Progress Report, July–September 1964. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-8. 223p. Dep.; $6.00(OTS).

Equipment tests are on schedule in the Sodium-cooled Reactor Experiment (SRE) as are write-ups of tests and operations manuals. The overall effort in SRE is about 53% complete. In the program to provide technical information on which to base the construction of a large sodium graphite reactor (SGR), major calandria design improvements were made. Fuel element studies in this program show that UC and UO_2 can be used interchangeably in the 200-Mwe prototype plant and that Zr-clad vented UC elements are practical under low-leakage conditions. A process for cutting and welding process tubes was developed. Bowed-graphite-log test results show that local stresses in the process tubes caused by graphite bowing will be less than 4000 psi. Development of fuels for the prototype design continued. Tests of 304 stainless steel revealed that it is satisfactory for fuel cladding. Design was completed on standard and special test fuel elements for irradiation in the SRE-PEP. In the program for advanced development of sodium cooled reactors, a project to evaluate effects of long-term reactor irradiation components in the SRE system was initiated. Work was completed on modification of the Large Component Test Loop (LCTL) and on the first phase of level indicator evaluation. A model of Na burning was developed and data from a large Na fire were analyzed. Preparations for a series of transient heating experiments in TREAT were completed. Analysis of the 11-in. Na-graphite-UC lattice was also completed. In the program to provide reliable and economic heat-transfer components for large Na-cooled power reactors, check-out of the Sodium Components Test Installation (SCTI) primary system was completed. The steam generator for SCTI was delivered, and welding of the tube-to-tube sheets was completed along with welding of evaporator modules for the test modular steam generator test. The operating surveillance of the U–Mo and UC elements in HNPF Core I shows that all fuel elements are operating satisfactorily. The nondestructive test equipment installation in the HNPF maintenance cell was checked out. The pre-irradiation measurements on 45% of the Core II UC fuel slugs were completed. A hot-cave complex was constructed for the second-cycle evaluation in UO_2 reprocessing. Scoping experiments carried out in the carbothermic reduction of ZrO_2 and Nb_2O_5 showed this process to be feasible. Progress is also reported in from studies of reactor physics, UC and other refractory fuels, BeO reactor materials, low-leakage reactor housing, neutron slowing down in moderators, neutron diffusion in water, graphite, and Be, neutron cross section data, fast spectrum Doppler measurements, fission product retention by coolants, neutron flux monitors, reactor safety, fission effects in metal fuels, high temperature chemistry, structure of metals and alloys, and radiation damage in crystalline solids. (J.R.D.)

12866 (NP-14554) BERICHT FUR DIE ZEIT VOM 1. JANUAR 1961 BIS 31. DEZEMBER 1962. (Report for the period January 1, 1961 to December 31, 1962). (Kernforschungsanlage, Julich, Germany). 161p. Dep.(mn).

The Annual Report of the Kernforschungsanlage at Julich is presented. The general development of the installation and administration staff is summarized. The studies undertaken in botany, zoology, agriculture, medicine, physical chemistry, radiochemistry, high energy physics, nuclear physics, neutron physics, engineering physics, reactor construction elements, reactor development, reactor construction materials, and plasma physics are reviewed. The scientific and engineering devices developed are summarized. The publications and papers presented at conferences are tabulated. (J.S.R.)

12867 (NP-14555) JAHRESBERICHT 1963. (Annual Report, 1963). (Kernforschungsanlage, Julich, Germany). 185p. Dep.(mn).

The Annual Report of the Kernforschungsanlage at Julich is presented. The general development of the installation and administration is summarized. The studies undertaken in botany, zoology, agriculture, medicine, physical chemistry, radiochemistry, chemical engineering, high energy physics, nuclear physics, neutron physics, engineering physics, reactor construction elements, reactor development, reactor construction materials, and plasma physics are reviewed. The scientific and engineering devices developed are summarized. The publications and papers presented at conferences are tabulated. (J.S.R.)

12868 (NP-14628) REPORT ON THE ACTIVITIES OF THE DANISH ATOMIC ENERGY COMMISSION, APRIL 1, 1963–MARCH 31, 1964. (Denmark. Atomenergikommissionen, Roskilde). Oct. 1964. 90p. Dep.(mn).

The research and development activities of the Danish Atomic Energy Commission are summarized. Information is reported on reactor physics, physics, electronics, research reactors, chemistry, construction, health physics, metallurgy, geology, linear accelerator, radiobiology, agriculture, radiation chemistry, international and local co-operation, education and training, general information services, technical and administrative organization, and finances. (N.W.R.)

12869 (NYO-1154-1) DISTRIBUTION STUDIES BETWEEN MELTS AND SOLID PHASES USING RADIOACTIVE TRACERS. Final Report. W. C. Orr and Peter Vilinskas (Connecticut. Univ., Storrs). Jan. 30, 1965. Contract AT(30-1)-1154. 105p. Dep.(mn); $4.00(cy), 2(mn) OTS.

The self-diffusion coefficient of sodium ions in soldalite ($Na_8Al_6Si_6O_{24}Cl_2$) was determined as a function of tempera-

ture between 307 and 720°C using sodium-22 as a tracer. The procedure consisted in observing the exchange of sodium between a molten salt containing the tracer and solid multicrystalline sodalite. The electrical conductivity of the natural mineral has been determined as a function of temperature. By assuming that the sodium ions are the only charge carriers, the ion mobility was estimated from the conductivity. From the mobility information obtained by the two different methods, conclusions could be drawn concerning the type of disorder present among the sodium ions and the mechanism of transport. In evaluating the results of the exchange experiments, the usual approximation of uniform spheres was discarded in favor of a distribution of spheres of various sizes. The solution of Fick's equation under these conditions is given, as well as the computer program used in its evaluation. (auth)

12870 (NYO-1480-9) THE NU-SPEAK SYSTEM. Judith Glasner, Stanley Ocken, David Rosenberg, Jack Schwartz, George Shapiro, and Alan Silverman (New York Univ., New York. Courant Inst. of Mathematical Sciences). Nov. 1964. Contract AT(30-1)-1480. 107p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Nu-Speak is a list processing language embedded in FAP. This manual describes the use of the Nu-Speak system, the use of a corresponding Fortran version of the system, and some applications. (auth)

12871 (NYO-2504-3) CREEP BY GRAIN BOUNDARY DIFFUSION. Report No. 298. A. L. Ruoff (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan. 7, 1965. Contract AT(30-1)-2179. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An equation for creep deformation where grain boundary diffusion is rate-controlling is derived: strain rate = $\dot{\epsilon} = 4D_B\delta\Omega\sigma_0/R^3kT$, where D_B = diffusion coefficient of grain boundary defects, δ = thickness of layer in which diffusion occurs, Ω = atomic volume, σ_0 = tensile stress, R = crystal radius, k = Boltzmann's constant, and T = absolute temperature. The conditions under which boundary and lattice diffusion contributions are equal, are discussed. The problem of measuring D_B is considered, particularly for ionic crystals. The use of the grain size dependence of the creep rate to determine the mechanism is pointed out. (D.L.C.)

12872 (NYO-2504-4) MASS TRANSFER PROBLEMS IN IONIC CRYSTALS. I. WITH CHARGE NEUTRALITY. Report No. 299. A. L. Ruoff (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan. 4, 1965. Contract AT(30-1)-2179. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A treatment is presented of the problem of transfer of vacancies in the diffusional creep of ionic crystals by the point defect mechanism. The transfer of defects via the lattice is considered, and Herring's work on lattice diffusion is discussed. It is shown that Herring's equations apply to a pure ionic crystal when the conduction is purely ionic, and that space charge effects can be ignored if the diffusion coefficient and atomic volume are replaced by molecular constants. (D.L.C.)

12873 (ORNL-P-829) FINE STRUCTURE OF LAMPBRUSH CHROMOSOMES. O. L. Miller Jr., (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng. 26p. (CONF-734-4). Dep.(mn); $2.00(cy), 1(mn) OTS.

From Symposium on Genes and Chromosomes Structure and Function, Buenos Aires, Nov.-Dec. 1964.

The lampbrush chromosomes of amphibian oocytes can readily be isolated in a condition which closely resembles their appearance in the living cell. These meiotic chromosomes are relatively uncoiled and in a highly extended state when compared with chromosomes in other cell types. In addition, labeling with radioactive precursors shows that continual, rapid synthesis of both RNA and protein is occurring on these chromosomes. Thus, the lampbrush chromosome offers a unique opportunity for critically examining both basic chromosome structure and structural aspects of at least one chromosome function, the transcription of RNA. Results are reported from studies on the structure and ribonucleoprotein matrix of lateral loops of chromosome preparations from Triturus viridescens. Microcentrifugation methods are described that were used to prepare specimens for light and electron microscopic studies. (C.H.)

12874 (SC-R-64-1376) TREE DIAGRAMS APPLIED IN ANALYSIS OF TIME-DEPENDENT SYSTEM FAILURE RATES. F. W. Mueller (Sandia Corp., Albuquerque, N. Mex.). Nov. 1964. Contract [AT(29-1)-789]. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Sandia Corp. Monograph.

The extension of tree diagrams to systems in which the times of component failures are continuous random variables, is illustrated with a specific example. The techniques used in developing tree diagrams are reviewed briefly. It is concluded that tree diagrams can be used to obtain density functions for time-dependent systems. (D.L.C.)

12875 (SC-RR-64-1796) PRESSURE DISTRIBUTIONS ON SPHERE CONES. D. M. Ellett (Sandia Lab., Albuquerque, N. Mex.). Jan. 1965. Contract [AT(29-1)-789]. 52p. Dep.; $3.00(OTS).

Except for the information contained in a Russian publication, little pressure distribution data on sphere cones have been found in the open literature. In the present study, the results of the Russian calculations have been transformed to the units used widely in this country, then they have been tabulated and plotted, both (1) as a pressure ratio of the local static cone pressure to the stagnation point pressure versus the normalized surface distance (p_c/p_{T_2} versus S/R) and (2) as a coefficient of pressure versus the normalized surface distance (C_p versus S/R). There pressure distributions are calculated for cone angles of 0, 5, 10, 20, 30, and 40 degrees and for Mach numbers of 3, 4, 6, 10, and infinity. The cone angle is defined as the angle between the cone surface and the axis of symmetry of the cone. (auth)

12876 (SC-TM-64-669) PHANTOM GAGE DIMENSIONING. Combined Part/Gage Specifications. E. S. Roth (Sandia Lab., Albuquerque, N. Mex.). July 1964. Contract [AT(29-1)-789]. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A new design definition technique, requiring no standard, is discussed that pictorially shows part and gage limits on the same drawing. When functional gages, test fixtures, or optical chart gages are the selected inspection method, design, manufacturing-process, and gage engineers can use these drawings directly to replace the usual standards-based drawings. In essence, this advanced technology visually describes true position dimensioning and tolerancing. It enables product designers to directly control the acceptance process. (auth)

12877 (SC-TM-64-1763) ELEMENTS AND SYSTEMS OF TRANSIENT WAVEFORM RECORDING. J. B. Szymanski (Sandia Lab., Albuquerque, N. Mex.). Dec. 1964. Contract [AT(29-1)-789]. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An attempt is made to identify the common features of transient waveform recorders by isolating and explaining, by practical examples, the three elements of any system. Although a survey was conducted, no attempt to cover the field completely is made since this aspect is already adequately treated. Rather, the survey information is filtered and distilled to obtain the essentials of transient waveform recording. (auth)

12878 (SC-TM-64-1784) AUTOMATED PLOTTING OF FLOW CHARTS ON A SMALL COMPUTER. H. E. Anderson (Sandia Lab., Albuquerque, N. Mex.). Jan. 1965. Contract [AT(29-1)-789]. 69p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A computer program is described which accepts Fortran II source programs as input data and which produces annotated flow charts as output. The program is unique in that a digital incremental plotter is used as the output medium, and the fact that the program is designed for a small (40,000 digits storage) computer. (auth)

12879 (TID-7031) A HANDBOOK OF ABBREVIATIONS AND NICKNAMES CONCERNED WITH ATOMIC ENERGY. Charles B. Yulish, comp. and ed. (New York Operations Office, AEC). May 1964. 204p. Dep.; $5.00 (OTS).

A compilation is presented of the meanings of many abbreviations used in atomic energy activities. The abbreviations refer to reactors, fusion devices, critical assemblies, nuclear weapons, the AEC and its laboratories and contractors, Dept. of Defense offices and projects, report codes, etc. (D.L.C.)

12880 (TID-21235) AXISYMMETRICAL FOIL BEARING — COMPRESSIBLE FLOW. E. Barlow (Ampex Corp., Redwood City, Calif.). June 1964. Contract Nonr-3815-(00). 30p. (RR-64-6). Dep.(mn); $1.00(cy), 1(mn) OTS.

The axisymmetrical foil bearing is studied with effects of compressibility being included. The pressure and gap profiles are found by numerically integrating the governing equations. The results are compared with the corresponding results obtained in a previous report on an approximate solution of the same problem assuming incompressible flow. (auth)

12881 (TID-21445) NUTRITIONAL PHYSIOLOGY OF THE WHITE-TAILED DEER. Report of Progress on Research, 1964. Robert L. Cowan, E. W. Hartsook, and J. S. Lindzey (Pennsylvania State Univ., University Park). Contract AT(30-1)-3470. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The influence of season and stage of antler development on the metabolism of P in young white-tailed deer was studied after the intravenous or intraruminal injection of a tracer dose of ^{32}P. The deer were kept in metabolism cages fitted for the quantitative collection of feces and urine, were sacrificed at the end of 72 hr, and the activity of tissue samples and excreta was counted. No difference in tissue distribution of ^{32}P was observed as a result of the injection route. Results indicated that the extremely high activities of the pedicle and other bones of the head that were observed were associated with antler growth. Lower values found in the period of antler quiescence indicated that these bones do not store minerals. (C.H.)

12882 (TID-21573) THE EFFECT OF GEOMETRIC FACTORS IN SURFACE REACTION SYSTEMS. Technical Report No. 48. Linden A. Pember and Milton E. Wadsworth (Utah. Univ., Salt Lake City). Nov. 9, 1964. Contract AT (11-1)-1144. 42p. Dep.(mn); $2.00(cy), 1(mn) OTS.

In surface reactions in which one solid is converted to another by means of oxidation or reduction, geometric factors reflect themselves in the kinetic pattern followed. Because the interfacial area between the two phases varies in the case of the reaction of nonplanar solids the variation must be correlated to separate the true reaction kinetics. In such systems, geometric factors are helpful in that by correlating the surface reactions with geometry equations it is possible to determine the direction of diffusion of the reactive species through the surface layers. In this study copper spheres were oxidized in oxygen to Cu_2O. Also synthetic cylinders of magnetite (Fe_3O_4) were oxidized in water vapor to hematite (Fe_2O_3). For the case of spherical and cylindrical copper samples it was found that the diffusion functions developed, fit conditions for the diffusion of copper ions outward from the metal through the oxide layers. The magnetite-hematite system was selected because marker studies have indicated that in hematite, (Fe_2O_3) diffusion occurs mainly by oxygen ion diffusion through oxygen ion vacancies. Results of these studies indicate that oxygen ions do diffuse inwardly and in all cases the geometric factors correlate the kinetic data observed directly. (auth)

12883 (TID-21592) TRIAXIAL COMPRESSION TESTS OF SALT ROCK CORES FOR THE UNITED STATES ATOMIC ENERGY COMMISSION, PROJECT DRIBBLE. Laboratory Report No. C-1043. (Bureau of Reclamation. Office of Assistant Commissioner and Chief Engineer, Denver). Oct. 29, 1962. 68p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Triaxial compression tests were made on 18 salt specimens at lateral pressures ranging from zero to 5,000 psi. The paired values of the principal stresses were then used to obtain curvilinear analyses of the principal stress relations and Mohr's envelope by electronic computer methods. The deformation of salt under triaxial loading is substantially greater than that of most other types of rock. The large deformations encountered in the initial tests prompted three important modifications in the program. First, the majority of specimens tested continued to deform throughout the full travel of the triaxial test machine ram, without apparently developing the usual symptoms of failure in the specimen, such as a significant dropoff in the indicated load. These specimens were subjected to another loading cycle. Second, the extraordinary deformation and flow of the salt under the test loading conditions made it highly desirable to obtain axial deformation measurements on at least some of the specimens. Thus, development of a deformation gage during the investigation provided for analysis of data for shear strength at selected deformations as well as at maximum loads obtained. Third, the occurrence of these large deformations led to adjustment of computed axial stresses to account for change in specimen diameter. That is, an area-correction formula was applied to determine the effective cross-sectional area of the specimen, and a corrected axial stress was thus obtained for use in computing the principal stress relationships and Mohr's envelopes. Eight separate analyses of the test data were made. These are based on four conditions of deformation: deformation at maximum load, and at 2, 10, and 20 percent deformation. For each condition, one analysis was made on the basis of computed axial stresses, and a second analysis made with axial stresses corrected for change in cross-sectional area of the specimens. Deformation measurements were obtained on 11 of the 18 specimens tested. Stress-strain curves for these cores provided the information for computing shear strength data at these selected deformations. (auth)

12884 (TID-21609) DATA PROCESSING FOR ISENTROPIC ANALYSES. Technical Report No. 1. Robert T. Duquet (Pennsylvania State Univ., University Park. Coll. of Mineral Industries). Dec. 1964. Contract AT(30-1)-3317. 39p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A program for computing the complete set of meteorological parameters required for isentropic analysis and for cross-section analysis is presented. Except for two minor subroutines, the program was written in FORTRAN language. The input data may be specified according to several different formats, including one which is nearly identical to the international teletype code for radiosonde reports. The operations performed by the program are equivalent to the graphical procedures for processing original radiosonde observations on a Stüve diagram. (auth)

12885 (UCRL-11855) NONLINEAR RESONANCE FOR DUFFING'S DIFFERENTIAL EQUATION (thesis). Loren P. Meissner (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1965. Contract W-7405-eng-48. 75p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Some sufficient conditions are given for the existence and uniqueness of solutions to the problem $Py = Qy - \lambda \cdot y = 0$ when a solution y_0 has been found for $\lambda = 0$; i.e., $Qy_0 = 0$. These conditions are applied to the Duffing problem, namely $\gamma^2 \cdot D^2y(\theta) + y(\theta) + \beta \cdot y^3(\theta) = \cos\theta$ with $y(\pi/2) = 0$ and $Dy(0) = 0$, in two separate areas: first, to prove the existence of a sequence of solutions tending to the solution of the "reduced" problem, $\gamma = 0$, in spite of the failure of the standard singular perturbation approach; and second, to rigorously show the nature of the principal solutions near several low-order resonances (γ near 1), including the divergence of the solutions into two separate branches in a region of resonance. Quantitative information is presented concerning solutions of the Duffing problem for various values of β and γ (particularly in the region $0 < \beta \leq 1$, $0 \leq \gamma \leq 1$) and the numerical procedure for obtaining these results is described. Data are given to

substantiate the theoretical results by illustrating the behavior of solutions for small values of γ, and by exhibiting the solution and the divergence into branches in low-order resonance regions. (auth)

12886 (UCRL-Pub-49) INTERIM STATUS REPORT — FISCAL YEAR 1964. (California. Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 60p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The research and development activities of the Lawrence Radiation Laboratory during the fiscal year 1964 are summarized. Information is included on: physics, chemistry, biology, medicine, Plowshare Project, accelerators, engineering, health physics, business services, administration, finances, rocket reactors, and technical information. (N.W.R.)

12887 (AEC-tr-6227/3) BULLETIN OF THE BORIS KIDRIC INSTITUTE OF NUCLEAR SCIENCES. Translation of Bilten Instituta za Nuklearne Nauke "Boris Kidric," 15: No. 3, 1964. 58p. Dep.; $3.00(OTS).

Six articles are presented which treat various topics in nuclear physics, radiation chemistry, diketone-metal complexes, activation analysis, and chromatographic separations. Separate abstracts were prepared for all the articles. (D.L.C.)

For abstracts of individual papers see: 10985, 11056, 11266, 11502, 12494, and 12495.

12888 INDUSTRIAL PARTICIPATION IN THE DEVELOPMENT OF NUCLEAR ENERGY IN FRANCE. J. N. Baville. Energie Nucl., 6: 349-54(Sept.-Oct. 1964). (In French)

The status of French nuclear industrial development is examined. Future trends are also examined, and the cooperation between the CEA and industry is reviewed. The possibilities of local industrial development are examined in relation to foreign markets. (J.R.D.)

12889 IMPROVED GAS-SOLIDS CONTACTING METHOD. R. P. Levey (to U. S. Atomic Energy Commission). U. S. Patent 3,164,440. Jan. 5, 1965.

A method for contacting solids with a gas is described. A fluidizing gas is introduced into the bottom of a bed of solids contained within a fluidizing zone in pulses of 30 to 150 cpm and at a pressure of 3 to 10 times the pressure exerted by the bed of solids on the bottom of the bed. This technique makes possible a great increase in the gas flow through the bed of solids. (AEC)

12890 N,N-DIFLUOROALKYLAMINES. Jack W. Frazer (to U. S. Atomic Energy Commission). U. S. Patent 3,166,595. Jan. 19, 1965.

A new series of compounds, the N,N-difluoroalkylamines, is described. N,N-difluoromethylamine and N,N-difluoroethylamine are representative. The compounds have utility as explosives and mono-propellant rocket fuels for space vehicles. (AEC)

12891 LIQUID LEVEL CAPACITANCE PROBE. John C. Bronson (to U. S. Atomic Energy Commission). U. S. Patent 3,167,695. Jan. 26, 1965.

A liquid level capacitance probe is described in which the improvement lies in constructing the electrodes from sintered porous metals having approximately 50% voids whereby a free transfer of gas may occur through the electrodes. (AEC)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

Conferences

Proceedings of conferences and conference papers are included in the Report Number Index.

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(4) Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce, Springfield, Virginia 22151, for sale as full-size printed copy, photostat or facsimile (Xerox), and microfilm. Reports included after September 18, 1964, are available either in full size or as photographically enlarged copy (two-thirds of original size), depending upon stock on hand. These reports are also available in 105mm by 148mm micronegative (microfiche) form.

(5) Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, for sale as full-size printed copy.

Public Availability of Non-AEC Reports

U. S. Reports. Many reports of U. S. Government agencies other than the AEC can be obtained by the public in the same manner as AEC reports. The availability of these reports is given when known. If availability is not shown, inquiries should be directed to the Clearinghouse for Federal Scientific and Technical Information. Inquiries concerning "NP" reports should be by title and author rather than by report number.

Non-U. S. Reports. Many reports of atomic energy establishments of other countries are deposited in the libraries listed on the inside covers of each issue of *NSA*.

Additionally, the following countries have made their reports available as indicated.

AUSTRALIA

Australian Atomic Energy Commission Research Establishment. Available upon request from the Library, Australian Atomic Research Establishment, Private Mail Bag, Sutherland, New South Wales, Australia.

BELGIUM

Centre d'Étude de l'Énergie Nucléaire. Available upon request to individuals and organizations, from the Centre d'Étude de l'Énergie Nucléaire (CEN), 31, Rue Belliard, Bruxelles, Belgium.

CANADA

Atomic Energy of Canada Limited. For sale by the Technical Information Officer, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada. Copies are also deposited in libraries in the United Kingdom.

National Research Council of Canada. Available from the National Research Council of Canada, Ottawa 2, Ontario, Canada.

DENMARK

Atomic Energy Commission Research Establishment, Risø. Available on exchange from the Library, Danish Atomic Energy Commission, Risø, Roskilde, Denmark. Also for sale by Jul. Gjellerup, Booksellers, 87 Sölvgade, København K., Denmark.

Danatom. Available on loan from Research Establishment, Risø, Roskilde, Denmark. Copies are available from Danatom, Aurehøjvej 2, Hellerup, Denmark.

FRANCE

Commissariat à l'Énergie Atomique. Inquiries for reports numbered 1-2199 should be addressed to Commissariat à l'Énergie Atomique, Service Central de Documentation, Centre d'Études Nucléaires de Saclay, Boite Postale No. 2, Gif-sur-Yvette (S. et O.), France. Reports numbered 2200 and above are available from La Documentation Francaise, 16 Rue Lord-Byron, Paris VIII, France.

Service Central de Protection contre les Rayonnements Ionisants. Copies are available from Ministère de la Santé Publique, Service Central de Protection contre les Rayonnements Ionisants, B. P. n° 35—LE VESINET (S. et O.), France.

GERMANY

Deutsches Elektronen-Synchrotron DESY. Copies are available from Deutsches Elektronen-Synchrotron Desy, Dokumentation, 2000 Hamburg-Gr. Flottbek 1, Notkestieg 1, Germany.

Kernforschungsanlage. Copies may be ordered from Zentralbibliothek der Kernforschungsanlage Jülich, Jülich, Bundesrepublik Deutschland.

Hahn-Meitner-Institute für Kernforschung. Available without charge from Hahn-Meitner-Institute für Kernforschung Berlin, Bibliothek, Glienicker Strasse 100, 1 Berlin 39, Germany. Copies are deposited in many national nuclear centers in the world.

Johann-Wolfgang-Goethe Universität, Frankfurt Am Main, Institut für Kernphysik, (IKF). Copies are available from Gmelin Institut, 40-42 Varrentrappstrasse, Frankfurt (Main), West Germany.

ISRAEL

Israel Atomic Energy Commission. Available without charge from Ministry of Defence/Atomic Energy Commission, Soreg Research Establishment, Yavne, Israel. Copies are deposited in libraries in Israel and in other countries.

ITALY

Centro Informazioni Studi Esperienze (CISE). For sale at CISE Press Office, Casella Postale 3986, Milano, Italy. Copies are deposited in libraries in Italy.

Comitato Nazionale per l'Energia Nucleare. Copies are available from Comitato Nazionale per l'Energia Nucleare, Divisione Affari Internazionali e Studi Economici, Ufficio Pubblicazioni, Via Belisario, 15, Roma, Italy.

JAPAN

Japan Atomic Energy Research Institute (JAERI). Available from the Staff Supply Cooperative of Japan Atomic Energy Research Institute (JAERI), 1-1 Tamura-Cho, Shiba, Minato-Ku, Tokyo, Japan. Copies are deposited in depositories in Tokyo, Nagoya, and Osaka.

Nagoya University. Copies are available from Research Information Center, Institute of Plasma Physics, Nagoya University, Nagoya, Japan.

University of Tokyo. Available free of charge from Institute for Nuclear Study, University of Tokyo, Tanashi-Machi, Kitatama-gun, Tokyo, Japan.

NETHERLANDS

Reactor Centrum Nederland. For sale by Reactor Centrum Nederland, 112 Scheveningseweg, 's-Gravenhage, The Netherlands. Copies are deposited in university libraries in Holland and in many national nuclear centers in the world.

NEW ZEALAND

Institute of Nuclear Sciences. Copies are available from Librarian, Institute of Nuclear Sciences, D.S.I.R., Private Bag, Lower Hutt, New Zealand. Copies are deposited in other countries.

NORWAY

Forsvarets Forskningsinstitutt. Copies available from Norwegian Defence Research Establishment, Library, P. O. Box 25, Kjeller, Norway.

Institutt for Atomenergi. "KR" reports are available on an exchange basis from the Library, Institutt for Atomenergi, Box 40, Kjeller, Norway. Other series are not generally available to the public.

Norwegian Reactor School. Copies are available from The Library, Institutt for Atomenergi, P. O. Box 40, Kjeller, Norway.

PAKISTAN

Atomic Energy Center. Copies are available from Atomic Energy Center, P. O. Box 658, Lahore, (West Pakistan).

POLAND

Biuro Pełnomocnika Rządu do Spraw Wykorzystania Energii Jądrowej, (CLOR). Copies are available from Pełnomocnik Rządu d/s Wykorzystania Energii Jądrowej, Ośrodek Informacji Naukowej, Technicznej i Ekonomicznej, Warszawa, PK i N, Poland.

SPAIN

Junta de Energia Nuclear. "JEN" reports are available without charge from Servicio de Documentation, Junta de Energia Nuclear, Ciudad Universitaria, Madrid (3), Spain.

SWEDEN

Aktiebolaget Atomenergi. "AE" reports are for sale from Aktiebolaget Atomenergi, Library Section, Box 43041, Stockholm 43, Sweden. Bibliographies and literature surveys of the VDDIT- series may be obtained from Aktiebolaget Atomenergi, Information Office, Scientific and Technical Information, Box 43041, Stockholm 43, Sweden. Other series are not generally available to the public. Organizations in the atomic energy field may obtain copies from Aktiebolaget Atomenergi. Microcopy of AE reports is available from the International Documentation Centre, Tumba, Sweden.

SWITZERLAND

CERN European Organization for Nuclear Research. Available without charge from CERN European Organization for Nuclear Research, Geneva 23, Switzerland. Copies are deposited in libraries in 13 countries.

Eidgenössisches Institut für Reaktorforschung. "EIR" reports are available from Eidgenössiches Institut für Reaktorforschung, c/o Bibliothek, Würenlingen/Ag, Switzerland.

TURKEY

Turkish Atomic Energy Commission. Copies are available free of charge from T.A.E.C., Çekmece Nuclear Research Center, P. O. Box 1, Airport, Istanbul, Turkey.

UNITED KINGDOM

United Kingdom Atomic Energy Authority. Some reports are for sale in the United States by the British Information Service (BIS), 845 Third Avenue, New York, N. Y. 10022. United Kingdom reports generally may be purchased from Her Majesty's Stationery Office, London. Copies not for sale by Her Majesty's Stationery Office may be purchased in microcopy form from Micro Methods Limited, East Ardsley, Wakefield, Yorks, England. Report copies are deposited in a large number of libraries in England.

Conferences

Beginning with Volume 19, Number 1, new receipts of conference proceedings as well as individual papers from conferences will be included in this index. When a paper is received from a conference a distinctive number will be assigned to the conference in the form CONF-year-month-sequence. Individual papers will be numbered with this basic "CONF" number and in addition each will carry a further sequence number. For example, the first paper received from a conference held in January 1965 would be numbered CONF-650101-1. Conference proceeding from which no individual papers have been received will be similarly numbered with a basic number. When proceedings are abstracted the abstract will appear at the point of the basic "CONF" number for the conference. Since all information on conferences will be included in this Report Number Index the subject heading CONFERENCES will be discontinued with Volume 19, Number 1.

Abbreviations Used in Availability Column

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HMSO	Her Majesty's Stationery Office, London.
IAEA	Available from the International Atomic Energy Agency.
JCL	For sale by the Special Libraries Association Translation Center, John Crerar Library, 35 West 33rd Street, Chicago, Illinois 60616.
LC	For sale by the Library of Congress, Photoduplication Service, Washington, D. C. 20540.
NAS	National Academy of Sciences, National Research Council, Washington, D. C. 20418.
NRC	For sale by the National Research Council of Canada, Ottawa, Ontario, Canada.
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USGS	Available free of charge from the U. S. Geological Survey, Washington, D. C. 20242.

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CONF-804–	(Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 15–19, 1964)	
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22	19-11767	ORINS
24	19-11769	ORINS
CONF-620901	19-10726 19-10728	(9th Congress of the International Society of Hematology, Mexico City, Sept. 17–23, 1962) Proceedings
CONF-630401	19-11664	(Symposium in Applied Mathematics, New York, Apr. 30–May 2, 1963) Proceedings
CONF-630403	19-11634	(National Conference on Nuclear Energy; Application of Isotopes and Radiation, Pretoria, Apr. 5–8, 1963) Proceedings
CONF-630501	19-11041	(14th Annual Mid-America Spectroscopy Symposium, Chicago, May 20–23, 1963) Proceedings
CONF-630904	19-11511	(Conference on the Utilization of Semiconductor Detectors in Nuclear Physics, Liege, Belgium, Sept. 16–18, 1963) Proceedings
CONF-640402–	(American Mathematical Society Symposium on Application of Partial Differential Equations in Mathematical Physics, New York, Apr. 1964)	
1	19-11830	See NYO-1480-7
CONF-640501–	(Biophysical and Radiobiological Meeting, Marburg, May 29–30, 1964)	
1	19-11616	See SGAE-BL-9/1964
CONF-640502–	(Biomathematics Symposium, Houston, Tex., May 15, 1964)	
1	19-10928	See BNL-8664
CONF-640606–	(American Physical Society Summer Meeting, Denver, Colo., June 25–27, 1964)	
9	19-11820	ORINS. Gmelin, AED-CONF-64-147-1
10	19-12286	See CONF-640608
CONF-640608	19-12285	(Symposium on Quasi-Optics, New York, June 8–10, 1964) Proceedings
CONF-640701–	(International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris, July 6–11, 1964)	
1	19-12148	ORINS
2	19-12143	ORINS
3	19-12144	ORINS
4	19-12147	ORINS
5	19-12153	ORINS
6	19-12146	ORINS
7	19-12140	ORINS
8	19-12141	ORINS
9	19-12717	ORINS
10	19-11131	ORINS
26	19-12156	ORINS
35	19-11133	ORINS
40	19-12142	ORINS
51	19-12155	ORINS
67	19-12718	ORINS
78	19-11695	ORINS
91	19-12152	ORINS
92	19-11320	ORINS
93	19-11321	ORINS
94	19-12716	ORINS
97	19-12154	ORINS
98	19-11319	ORINS
103	19-12149	ORINS
104	19-12145	ORINS
110	19-12720	ORINS
CONF-640702–	(American Crystallographic Assn. Annual Meeting, Bozeman, Mont., July 26–31, 1964)	
1	19-11132	ORINS. Gmelin, AED-CONF-64-137-10
CONF-640901–	(3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964)	
7	19-12151	ORINS
12	19-12150	ORINS
16	19-11388	ORINS
CONF-640902–	(3rd International Measurement Conference, Stockholm, Sept. 14–19, 1964)	
6	19-11601	Acta IMEKO (Intern. Messtech. Konf.), 1964, 465-74
CONF-640905–	(VIIIth International Conference on Coordination Chemistry, Vienna, Sept. 7–11, 1964)	
1	19-11258	See EUR-2169.e
CONF-641003–	(3rd National Northern Development Conference, Edmonton, Canada, Oct. 21–23, 1964)	
1	19-12768	See AECL-2069
CONF-641006–	(48th Meeting of the Italian Society for the Progress of Science, Cagliari-Sassari, Italy, Oct. 4–Nov. 28, 1964)	
1	19-11265	See RT/GEO(64)-14
CONF-641201–	(American Institute of Chemical Engineers Annual Meeting, Boston, Dec. 6–10, 1964)	
1	19-11361	ORINS
4	19-11362	ORINS
8	19-11135	ORINS
11	19-11134	ORINS
12	19-11298	ORINS
13	19-11420	See ORNL-P-856
COO–		
119-231	19-10735	Dep.(mn); $5.00(cy), 3(mn) OTS
280	19-12771	Dep.(mn); $2.00(cy), 1(mn) OTS
774-5	19-11345	Dep.(mn); $2.00(cy), 1(mn) OTS
926-33	19-11346	$1.00(cy), 1(mn) OTS
1195-26	19-12196	Phys. Letters, 14: 151-3(1965)
1370-1	19-11816	Dep.(mn); $1.00(cy), 1(mn) OTS
1371-6	19-12593	Phys. Rev., 137: B882-903(1965)
1371-9	19-12218	Phys. Rev., 137: B935-48(1965)
1428-7	19-12162	Dep.(mn); $2.00(cy), 1(mn) OTS
CR–	(Misc.)	
72	19-12105	See AD-608345
CU–	(Misc.)	
230	19-12167	See NEVIS-124
2663-14	19-12862	Dep.(mn); $2.00(cy), 1(mn) OTS
2663-17	19-11389	Dep.(mn); $2.00(cy), 1(mn) OTS
CVNA–	(Misc.)	
195	19-12772	Dep.(mn); $2.00(cy), 1(mn) OTS
D–	(Misc.)	
2-20282-1	19-11667	
2-20646	19-11384	
DASA–	(Misc.)	
1406	19-11380	$10.50(OTS)

Report No.	Abstract No.	Availability
DLCS–		
5001064	19-12773	Dep.(mn); $2.00(cy), 1(mn) OTS
DP–		
929	19-12863	Dep.; $4.00(OTS)
945	19-11668	Dep.; $2.00(OTS)
DPSPU–		
64-30-4	19-11416	Dep.(mn); $1.00(cy), 1(mn) OTS
64-30-9	19-10740	Dep.(mn); $1.00(cy), 1(mn) OTS
EACRP-U–	**(European-American Committee on Reactor Physics)**	
17	19-12729	Dep.(mn)
EU–	**(German)**	
B35	19-11725	See EURAEC-1245
EUR–	**(European Atomic Energy Community)**	
1637.f	19-12454	Dep.(mn)
1909.d	19-11615	Dep.(mn)
2160.e	19-11655	Dep.(mn)
2162.e	19-12748	Dep.(mn)
2169.e	19-11258	Dep.(mn)
2173.i	19-12749	Dep.(mn)
2174.i	19-12455	Dep.(mn)
2175.f	19-12774	Dep.(mn)
2190.f	19-12775	Dep.(mn)
2193.e	19-11347	Dep.(mn)
2209.e	19-11165	Dep.(mn)
EUR-CEA–	**(European Atomic Energy Community)**	
FC-247	19-12632	Dep.(mn)
EURAEC–		
1099	19-11722	Dep.(mn); $3.00(cy), 2(mn) OTS
1162	19-12776	Dep.(mn); $3.00(cy), 2(mn) OTS
1207	19-11723	Dep.(mn); $2.00(cy), 1(mn) OTS
1213	19-11690	Dep.(mn); $2.00(cy), 1(mn) OTS
1217	19-11724	Dep.(mn); $2.00(cy), 1(mn) OTS
1219	19-11348	Dep.(mn); $2.00(cy), 1(mn) OTS
1221	19-11691	Dep.(mn); $1.00(cy), 1(mn) OTS
1224	19-11349	Dep.(mn); $1.00(cy), 1(mn) OTS
1231	19-12777	Dep.(mn); $1.00(cy), 1(mn) OTS
1239	19-11698	Dep.(mn); $1.00(cy), 1(mn) OTS
1243	19-11777	Dep.(mn); $3.00(cy), 1(mn) OTS
1245	19-11725	Dep.(mn); $1.00(cy), 1(mn) OTS
1265	19-12456	See GEAP-4731
1268	19-11778	Dep.(mn); $1.00(cy), 1(mn) OTS
1273	19-10980	Dep.(mn); $3.00(cy), 1(mn) OTS
1291	19-11344	See ACNP-64029
FTD-TT–	**(Non-AEC)**	
64-101	19-12644	$1.00(OTS)
64-103	19-12133	OTS
GA–	**(Misc.)**	
5800	19-12734	Dep.(mn); $3.00(cy), 2(mn) OTS
GAM-ME–	**(Non-AEC)**	
64-22	19-12128	See AD-604827
GAMD–	**(Misc.)**	
3058	19-11304	Dep.(mn); $1.00(cy), 1(mn) OTS
GEAP–	**(Misc.)**	
3152	19-12804	Dep.(mn); $1.00(cy), 1(mn) OTS
3248	19-12805	Dep.(mn); $2.00(cy), 1(mn) OTS
3250	19-12806	Dep.(mn); $2.00(cy), 1(mn) OTS
3252	19-12807	Dep.(mn); $3.00(cy), 2(mn) OTS
3303	19-12808	Dep.(mn); $3.00(cy), 2(mn) OTS
3367	19-12809	Dep.(mn); $4.00(cy), 3(mn) OTS
3375(Rev.1)	19-12810	Dep.(mn); $2.00(cy), 1(mn) OTS
3559	19-12811	Dep.(mn); $3.00(cy), 2(mn) OTS
4644	19-12778	Dep.(mn); $2.00(cy), 1(mn) OTS
4731	19-12456	Dep.(mn); $1.00(cy), 1(mn) OTS
4732	19-12779	Dep.(mn); $1.00(cy), 1(mn) OTS
4741	19-12780	Dep.(mn); $3.00(cy), 2(mn) OTS
GEMP–	**(Misc.)**	
41A	19-11669	Dep.; $3.00(OTS)
GEST–	**(Misc.)**	
2042	19-12130	
HPR–	**(Norwegian)**	
37	19-12781	Dep.(mn)
HRD–	**(Non-AEC)**	
63736	19-11305	
HW–		
65182RD	19-11306	Dep.(mn); $1.00(cy), 1(mn) OTS
66216	19-11656	$1.00(cy), 1(mn) OTS
68600-46	19-12864	Dep.; $2.00(OTS)
71500B	19-11779	Dep.; $4.00(OTS)
75132	19-11471	$1.00(cy), 1(mn) OTS
82153(Rev.1)	19-11325	Dep.(mn); $1.00(cy), 1(mn) OTS
83092	19-12802	Dep.(mn); $1.00(cy), 1(mn) OTS
83447	19-11472	Dep.(mn); $2.00(cy), 1(mn) OTS
83604	19-11670	Dep.; $2.00(OTS)
83818	19-11259	Dep.; $2.00(OTS)
84082	19-12837	$1.00(cy), 1(mn) OTS
HW-SA–		
3466	19-11555	Nucl. Instr. Methods, 31: 339-40(1964)
3565	19-12750	Dep.(mn); $2.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-081-32
3719	19-10852	Nature, 205: 99-100(1965)
HWS–		
6574(Rev.1)	19-11326	Dep.(mn); $1.00(cy), 1(mn) OTS
IA–	**(Non-AEC)**	
937	19-11662	Rev. Mod. Phys., 37: 204-14(1965)
992	19-11166	Dep.(mn)
1004	19-11048	Dep.(mn)
IDO–		
10044	19-12838	Dep.(mn); $3.00(cy), 2(mn) OTS
10045	19-12839	Dep.(mn); $2.00(cy), 1(mn) OTS
10046	19-12840	Dep.(mn); $3.00(cy), 2(mn) OTS
17030	19-12841	Dep.; $3.00(cy), 2(mn) OTS
IPP–	**(German)**	
1/10	19-12633	Dep.(mn)
1/17	19-11473	Dep.(mn)
4/15	19-11699	Dep.(mn)
6/22	19-12634	Dep.(mn)
8	19-12635	Dep.(mn)
IPPJ–	**(Japanese)**	
29	19-12636	Dep.(mn)
IRD–	**(British)**	
64-36(Pt.1)	19-12131	$6.00(OTS)
64-36(Pt.2)	19-12132	$3.00(OTS)
IS–		
946	19-11090	J. Chem. Phys., 42: 1135-9(1965)
975	19-11751	Phys. Rev., 137: A1139-45(1965)
996	19-11085	J. Chem. Phys., 42: 981-92(1965)
JINR–	**(Russian)**	
E-1850	19-12326	Dep.(mn)
E-1861	19-12482	Dep.(mn)
P-1829	19-12163	Dep.(mn)
P-1846	19-12483	Dep.(mn)
P-1852	19-12484	Dep.(mn)
P-1860	19-12164	Dep.(mn)
P-1865	19-12485	Dep.(mn)
P-1883	19-12486	Dep.(mn)
P-1886	19-12165	Dep.(mn)
P-1889	19-12166	Dep.(mn)
P-1903	19-12457	Dep.(mn)
JPRS–	**(Non-AEC)**	
27527	19-10930	$2.00(OTS)
27565	19-10743	$1.00(OTS)
27762	19-10931	$1.00(OTS)
28345	19-10792	$1.00(OTS)

Report No.	Abstract No.	Availability
JüL–	**(German)**	
174-MA	19-11658	Dep.(mn)
179-RX	19-12458	Dep.(mn)
K–		
1466	19-11049	Dep.; $1.00(OTS)
KFK–	**(German)**	
245	19-11474	Dep.(mn)
KFKI–	**(Hungarian)**	
64-2	19-11826	Dep.(mn)
64-4	19-12327	Dep.(mn)
KR–	**(Norwegian)**	
80	19-10981	Dep.(mn)
LA–		
3202-MS	19-12637	Dep.; $4.00(OTS)
LA-DC–		
6489	19-12585	Phys. Rev., 137: B809-13(1965)
6497	19-11106	J. Phys. Chem., 69: 176-81(1965)
6567	19-11542	Nucl. Instr. Methods, 31: 226-32(1964)
6597	19-12597	Phys. Rev., 137: B929-35(1965)
6741	19-11883	Nucl. Instr. Methods, 32: 357-9(1965)
LADC–		
6434	19-12586	Phys. Rev., 137: B814-25(1965)
6473	19-12587	Phys. Rev., 137: B826-36(1965)
LAL–	**(French)**	
1115	19-12487	Dep.(mn)
LGI–	**(Italian)**	
64/4	19-11827	Dep.(mn)
LNF–	**(Italian)**	
63/82	19-11864	Dep.(mn)
64/45	19-11865	Dep.(mn)
MATT–		
262	19-12672	Phys. Fluids, 8: 118-33(1965)
312	19-12638	Dep.(mn); $1.00(cy), 1(mn) OTS
MCW–		
1490	19-11050	Dep.; $2.00(OTS)
MF–	**(Misc.)**	
41	19-11830	See NYO-1480-7
MIT–	**(Misc.)**	
2098-101	19-12555	Phys. Letters, 14: 129-33(1965)
ML-TDR–	**(Non-AEC)**	
64-63	19-11700	OTS
MLM–		
1225J	19-11081	J. Chem. Phys., 42: 869-72(1965)
MSAR–	**(Misc.)**	
64-144	19-11692	Dep.(mn); $2.00(cy), 1(mn) OTS
65-05	19-11726	Dep.(mn); $2.00(cy), 1(mn) OTS
N–	**(Misc.)**	
64-16006	19-12386	See NASA-TR-R-143
NAA-SR–		
5198	19-11167	Dep.; $0.50(OTS)
9889	19-11307	Dep.; $2.00(OTS)
10501	19-12865	Dep.; $6.00(OTS)
NAA-SR-Memo–		
10366	19-11475	Dep.(mn); $1.00(cy), 1(mn) OTS
10499	19-12812	Dep.(mn); $1.00(cy), 1(mn) OTS
10584	19-12724	Dep.(mn); $1.00(cy), 1(mn) OTS
10591	19-11308	Dep.(mn); $2.00(cy), 1(mn) OTS
NASA-CR–	**(Misc.)**	
150	19-12106	$2.00(OTS)
NASA-TN–	**(Misc.)**	
D-2591	19-11168	$1.00(OTS)
D-2594	19-12813	$1.00(OTS)
D-2626	19-11350	$2.00(OTS)
D-2635	19-11385	$1.00(OTS)
NASA-TR–	**(Non-AEC)**	
R-143	19-12386	$1.75(OTS)
R-219	19-12639	$2.00(OTS)
NBS–	**(Misc.)**	
8481	19-12428	Dep.(mn); $4.00(cy), 2(mn) OTS
NDL-TM–	**(Non-AEC)**	
15	19-11327	
NEVIS–	**(Misc.)**	
124	19-12167	
NMI–	**(Misc.)**	
2132	19-11701	Dep.(mn); $2.00(cy), 1(mn) OTS
NP–	**(AEC File No. for Non-AEC Reports)**	
14540	19-12168	Dep.(mn)
14547	19-11328	Dep.(mn)
14553	19-11329	Dep.(mn)
14554	19-12866	Dep.(mn)
14555	19-12867	Dep.(mn)
14591	19-12842	Dep.(mn); $3.00(cy), 2(mn) OTS
14628	19-12868	Dep.(mn)
14641	19-12429	Dep.(mn)
14644	19-12430	Dep.(mn)
14645	19-11828	Dep.(mn)
14658	19-11391	Dep.(mn)
14660	19-11476	
14662	19-11260	Dep.(mn)
14668	19-11261	Dep.(mn)
14669	19-10731	
14670	19-11417	Dep.(mn)
14671	19-12760	Dep.(mn)
14674	19-11829	
14678	19-11403	
14683	19-11392	Dep.(mn)
NRC–	**(Canadian)**	
8148	19-11175	Can. J. Chem., 42: 2684-94(1964)
NRL–	**(Misc.)**	
6119	19-11671	$0.50(OTS)
6179	19-11780	Dep.(mn); $1.00(cy), 1(mn) OTS
NRL-Memo–	**(Misc.)**	
1556	19-11781	Dep.(mn); $2.00(cy), 1(mn) OTS
NUS–	**(Misc.)**	
106	19-11477	
NYO–		
162-12	19-11418	Dep.(mn); $2.00(cy), 1(mn) OTS
1163-24	19-11404	Dep.(mn); $2.00(cy), 1(mn) OTS
NYO–		
1154-1	19-12869	Dep.(mn); $4.00(cy), 2(mn) OTS
1242-1	19-10929	Dep.(mn); $1.00(cy), 1(mn) OTS
1480-2	19-11657	Dep.(mn); $6.00(cy), 4(mn) OTS
1480-7	19-11830	Dep.(mn); $3.00(cy), 1(mn) OTS
1480-9	19-12870	Dep.(mn); $4.00(cy), 2(mn) OTS
2310-5	19-11169	See RRL-152
2471-6	19-11727	Dep.(mn); $5.00(cy), 3(mn) OTS
2504-3	19-12871	Dep.(mn); $1.00(cy), 1(mn) OTS
2504-4	19-12872	Dep.(mn); $1.00(cy), 1(mn) OTS
2564-1	19-10784	Dep.(mn); $1.00(cy), 1(mn) OTS
2910-7	19-11478	Dep.(mn); $1.00(cy), 1(mn) OTS
3421-1	19-11497	Dep.(mn); $2.00(cy), 1(mn) OTS
ORNL–		
3624	19-11309	Dep.; $3.00(OTS)
3631	19-12488	Dep.; $2.00(OTS)
3673	19-12489	Dep.; $2.00(OTS)

Report No.	Abstract No.	Availability
3689	19-12490	Dep.; $3.00(OTS)
3723	19-11672	Dep.; $3.00(OTS)
3727	19-12491	Dep.; $1.00(OTS)
3737	19-12761	Dep.; $2.00(OTS)
3756	19-12843	Dep.; $2.00(OTS)
ORNL-P–	**(Misc.)**	
50	19-12671	Phys. Fluids, 8: 110-18(1965)
97	19-12604	Rev. Mod. Phys., 37: 166-76(1965)
133	19-10814	Cancer Res., 25: 20-8(1965)
376	19-11109	J. Phys. Chem., 69: 303-9(1965)
565	19-12521	Nucl. Phys., 64: 259-72(1965)
579	19-12588	Phys. Rev., 137: B837-47(1965)
602	19-12590	Phys. Rev., 137: B850-65(1965)
744	19-11640	Dep.(mn); $5.00(cy), 3(mn) OTS
745	19-11419	Dep.(mn); $1.00(cy), 1(mn) OTS
829	19-12873	Dep.(mn); $2.00(cy), 1(mn) OTS
856	19-11420	Dep.(mn); $1.00(cy), 1(mn) OTS
ORNL-TM–		
657	19-11262	Dep.(mn); $1.00(cy), 1(mn) OTS
896	19-11263	Dep.(mn); $1.00(cy), 1(mn) OTS
937	19-11264	Dep.(mn); $2.00(cy), 1(mn) OTS
966	19-12596	Phys. Rev., 137: B913-28(1965)
1004	19-11673	Dep.(mn); $2.00(cy), 1(mn) OTS
1011	19-11782	Dep.(mn); $2.00(cy), 1(mn) OTS
1023	19-12844	Dep.(mn); $1.00(cy), 1(mn) OTS
1024(Rev.1)	19-12492	Dep.(mn); $1.00(cy), 1(mn) OTS
ORNL-tr–		
404	19-12787	Dep.(mn); $1.60(fs), $0.80(mf) JCL
406	19-11702	Dep.(mn); $1.60(fs), $0.80(mf) JCL
407	19-11703	Dep.(mn); $1.60(fs), $0.80(mf) JCL
409	19-11331	Dep.(mn); $2.60(fs), $0.92(mf) JCL
410	19-11730	Dep.(mn); $4.60(fs), $1.43(mf) JCL
PA-TR–	**(Non-AEC)**	
3153	19-12061	
PAN–	**(Polish)**	
534/IX-A	19-12751	Dep.
537/VI	19-12493	Dep.
538/XVIII	19-11831	Dep.
542/IX	19-12782	Dep.
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
972,534	19-11714	
972,583	19-11378	
972,686	19-11715	
972,734	19-12743	
972,928	19-11340	
972,943	19-11299	
973,050	19-11713	
973,101	19-11341	
973,137	19-12744	
973,158	19-12745	
973,176	19-11342	
973,322	19-11379	
973,466	19-11343	
973,674	19-12746	
973,820	19-11654	
973,839	19-11138	
PATENTS	**(German)**	
1,173,881	19-11139	
1,175,211	19-11300	
1,175,465	19-11043	
1,179,650	19-12765	
1,180,071	19-11604	
1,180,072	19-11605	
1,180,076	19-12038	
1,180,077	19-12039	
1,180,856	19-11044	
PATENTS	**(U. S.)**	
3,160,818	19-11496	
3,163,915	19-11606	
3,164,440	19-12889	
3,165,377	19-11301	
3,165,417	19-11716	
3,165,422	19-11717	
3,165,427	19-11688	
3,165,448	19-12766	
3,165,475	19-11140	
3,165,835	19-12747	
3,166,595	19-12890	
3,167,447	19-11141	
3,167,695	19-12891	
PATENTS	**(U.S.S.R.)**	
87,007	19-11689	
PG-Report–	**(British)**	
614	19-10982	Dep.; (BIS)
R–	**(Misc.)**	
63SD91	19-12640	$5.60(OTS)
352	19-10980	See EURAEC-1273
427	19-12167	See NEVIS-124
RADC-TDR–	**(Misc.)**	
63-352	19-10785	$1.60(OTS)
64-352	19-11832	$2.00(OTS)
RISLEY-Trans–	**(British)**	
287	19-12788	Dep.(mn); $3.60(fs), $1.13(mf) JCL
RLE-TR–	**(Non-AEC)**	
423	19-12641	
RM–	**(Misc.)**	
4238-TAB	19-11421	Dep.(mn); $2.00(cy), 1(mn) OTS
RR–	**(Misc.)**	
64-6	19-12880	See TID-21235
RRL–		
152	19-11169	Dep.(mn); $1.00(cy), 1(mn) OTS
RSG-A–	**(Non-AEC)**	
1	19-11422	
RT-GEO–	**(Italian)**	
(64)-14	19-11265	Dep.(mn)
SC-DC–		
64-1432	19-11051	$3.00(cy), 2(mn) OTS
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